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WILDLIFE-REFORESTATION PROBLEMS AND SEEDLING PROTECTION IN WESTERN OREGON: REVIEW AND CURRENT KNOWLEDGE

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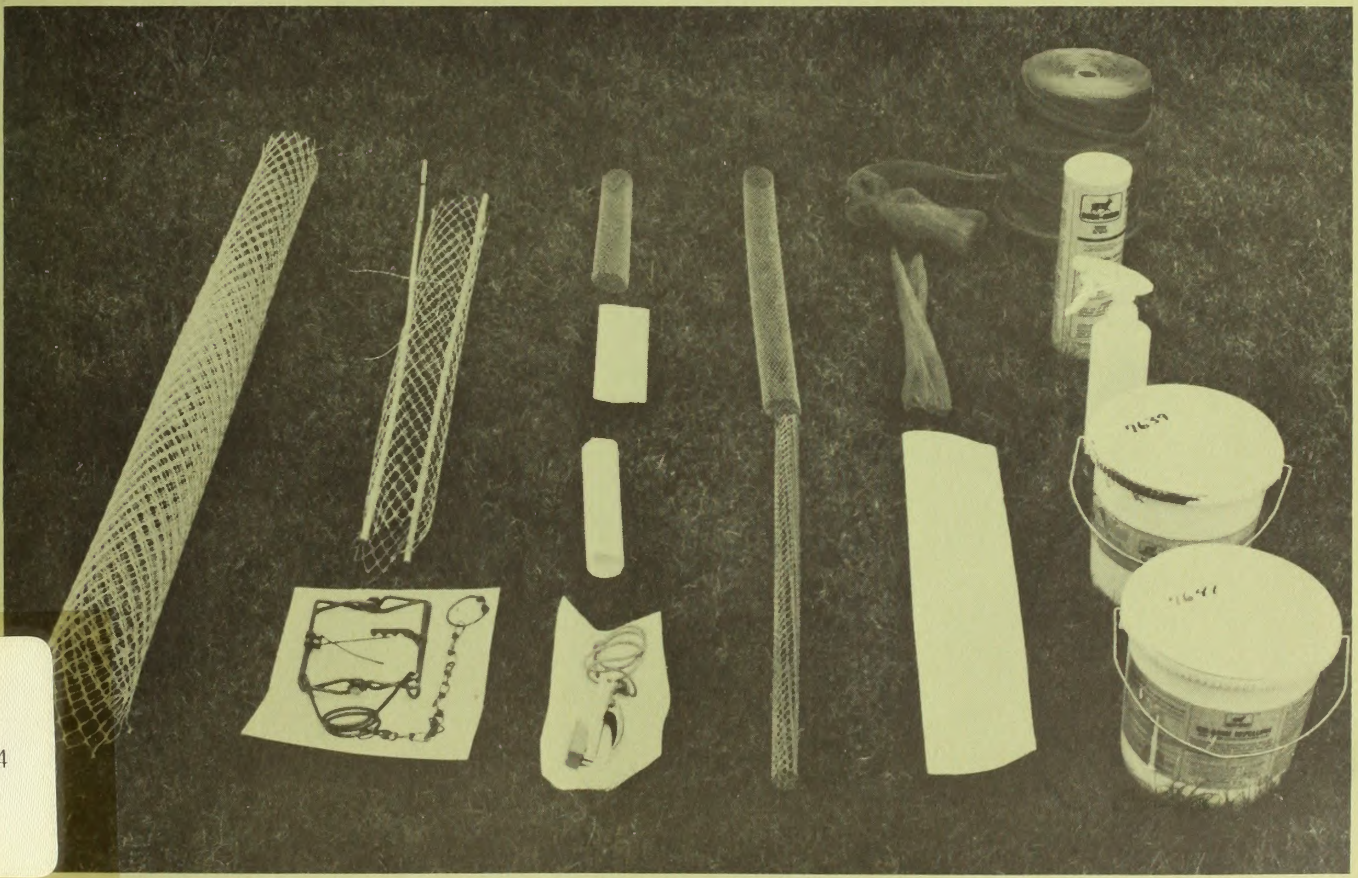


CONTENTS

FOREWARD

Forest managers for BLM and other lands in western Oregon have substantially increased their efforts to protect forest tree seedlings from damage by wildlife. Nearly half of their lands being reforested each year need protection. Managers must determine what animal is causing damage, which protection method to use, and what material to buy. They must also try to use the most cost-effective methods and materials. The lack of comparative data for many protective materials and methods makes selection of materials and approaches difficult. Changes in manufactured materials from year to year also complicates matters.

Besides timber productivity, forest managers must remember that they are in an era of extreme environmental awareness and have to be constantly aware of the aesthetic needs of the general public as well as the needs of wildlife. Undoubtedly, chemical pesticides will continue to be an integrel part of forest management. As such, managers must recognize and minimize the risks inherent in using pesticides. In brief, timber production, wildlife, and other goals can be achieved through wise use of chemical and nonchemical means and by **CONSULTING WITH SOMEONE FAMILIAR WITH DAMAGE CONTROL BEFORE INITIATING A CONTROL PROGRAM.**

ACKNOWLEDGMENTS

We particularly acknowledge the assistance of BLM foresters and biologists for providing forest-animal damage and control information relevant to their Districts and Resource Areas and for identifying nearby managers of private forest lands with similar concerns. Private land managers, Oregon State Forestry managers, and the U.S. Forest Service provided much information for this study. Manufacturers and suppliers of forest protection materials were very responsive in helping identify users of these products in western Oregon. The Oregon Forest Protection Association, Oregon Department of Fish and Wildlife, and Oregon State University assisted with a variety of information. Stanley Olmstead, U.S. Fish and Wildlife Service (USFWS), assisted in gathering field information and mapping locations of forest-animal damage problems.

EXECUTIVE SUMMARY

Methods used by BLM and other forest land managers to protect forest seedlings from animal damage in western Oregon and elsewhere were reviewed. A survey of more than 100,000 acres reforested annually by public agencies and private companies indicated that nearly half required protection from animals. Of the six commercial conifer species damaged, damage occurred most frequently to Douglas-fir. Animal damage to plantations could only be predicted by managers about half of the time. Heaviest damage occurred along the Coast Range. Cost-benefits for protection were not assembled because of obvious lack of useable data. Uniform cost-benefit information is needed for specific methods. Information was not readily available on animal damage to genetically improved stock because those trees were being grown inside fenced sites.

Black-tailed deer, mountain beaver, and elk caused most damage; mountain beavers caused most tree mortality. At least seven other wildlife species, including snowshoe hare, brush rabbit, and pocket gophers also damaged tree seedlings. Livestock also damaged plantations.

The primary methods used in the 1982-83 planting season for damage control were protection of individual seedlings with mechanical barriers and repellents and kill trapping mountain beaver. Rigid plastic mesh tubes were used on 44% of the acreage being protected from damage by mountain beaver, big game, and other species; waterproof paper bud caps were used on 23% of the acreage against big game; BGRR (Big Game Repellent) was used on 12% of the acreage against big game. Some land owners repeatedly used kill trapping for mountain beavers on about 80% of their land. Cost for most damage control methods is probably justified based on expenditure of about $150/acre for Site III land. Available methods, current studies, and research needs about forest-animal damage relations are summarized.

Whenever chemicals are considered for use against animal damage, the user should check the current registration status with the state Department of Agriculture, U. S. Fish and Wildlife Service, and the policy of the land owner or agency.

INTRODUCTION

The Bureau of Land Management (BLM) is responsible for managing about 2l/2 million acres of forest land in western Oregon of which about 90% is Oregon and California Railroad Company land decreed by Congress for continuous timber productivity. Production from these lands has local, state, regional, and national significance. The future of this production, in part, strongly lies in the success of forest managers to promptly reforest the lands in a timely manner and carry the required number of reforested trees through a rotation period.

There is considerable evidence that feeding injuries on newly planted seedlings by animals can adversely affect forest regeneration and the ultimate productivity of these lands (Black et al. 1979; Brodie et al. 1979). BLM is aware of this fact; so much so, that it is currently spending considerable funds to alleviate the problem.

Since the 1950's, a wide variety of protective measures have been investigated and used in the Pacific Northwest to reduce forest-animal damage. Many of these measures have been lost to the land manager for various reasons. In recent years, an equally wide variety of methods and materials that have never been thoroughly evaluated suddenly became available and are being used; the effectiveness of many of these has never been shown. To compound the current situation, animals that were minor problems years ago seem to be major problems now because of changes in forest management practices and reduced availability of tools to cope with certain problem animals.

In 1982, BLM identified the need to increase its knowledge of forest-animal damage problems and control on their forest lands in western Oregon. Knowledge of what neighboring forest land managers were faced with and doing about the problem was also desired. This need was expressed to the USFWS. The Service's Station in Olympia, Washington has a long history of research on forest-animal damage problems in the Pacific Northwest (Evans l974a). The Station also has authority to aid BLM and other agencies in answering animal damage concerns.

In short, the situation led to a cooperative agreement between BLM and FWS to compile a state-of-the-art manuscript on wildlife-reforestation problems and current solutions and research necessary. This paper presents this information. The data was gathered through first-hand observations, by conducting a survey of BLM lands and other ownerships in western Oregon, by questioning forest land managers on a one-to-one basis, and through literature review

OVERVIEW OF FOREST-ANIMAL PROBLEMS AND RESEARCH

Western Oregon has 13.7 million acres of timberland of which over half has the potential to produce 120 cubic feet of wood per acre per year, making it one of the most productive forest areas in the world (Gedney 1982). However, this productivity can be reduced by millions of dollars annually by animals (Brodie et al. 1979).

Forest managers and wildlife biologists recognized the need to protect tree seed and seedlings from animal damage in western Oregon and Washington soon after artificial regeneration of conifers by seeding and planting was started in the 1940's (Looney 1969). Seeding was sometimes successful by both natural and artificial methods but good results were unpredictable (Black 1969). Most failures were assessed to animals. By the mid 1970's, reforestation by seeding had nearly stopped. Over 90% is now done by planting with bare-root and container-grown seedlings. Planting has been more dependable than seeding in most habitats, but planted seedlings are still subjected to a variety of animal feeding injuries.

Animals identified as causing damage to young Pacific Northwest plantations include snowshoe hares *(Lepus americanus)*, brush rabbits *(Sylvilagus bachmani)*, black-tailed deer *(Odocoileus hemionus columbianus)*, black bear *(Ursus americanus)*, porcupine *(Erethizon dorsatum)*, pocket gophers *(Thomomys spp.)*, mountain beaver *(Aplodontia rufa)*, and voles or meadow mice *(Microtus spp.)* (Moore 1940). Changes in logging, planting, and site preparation methods as well as changes in some animal populations and damage control practices resulted in changes in the amount of damage caused by some animals. In western Oregon, at least, deer, elk *(Cervus elaphus roosevelti)* and mountain beaver now cause the most concern; rabbits, hares, and pocket gophers cause severe local concerns. Other animals that may cause local problems include blue grouse *(Dendragapus obscurus)*, western gray squirrels *(Sciurus griseus)*, dusky-footed wood rats *(Neotoma fuscipes)*, picas *(Ochotona princeps)*, and livestock. Information on some of the concerns and biology of these animals has been recently reviewed (U. S. Forest Service 1978; Evans 1981; Galt et al. 1981; Maser et al. 1981; Chapman and Feldhamer 1982); some of this information is included in this paper. Types of feeding injuries caused by these animals are illustrated in Lawrence et al. (1961); some are also included in this paper.

Early animal damage control in Pacific Northwest forest lands was mainly limited to killing the problem animals or using repellents. Early toxicants included strychnine, zinc phosphide, 1080, and experimental compounds like thallium sulfate and arsenic (Moore 1940; Hooven 1953; Kverno 1964; Kverno and Hood 1963; Evans 1974a). In 1956, endrin became available as a seed protectant in direct seeding (Lindsey et al. 1974); it is still federally registered and available for use. Before using endrin, however, it is advisable to check the regulations of any agency or company involved, and to check with the pesticide division of the state department of agriculture. One repellent successfully used for many years to reduce hare and rabbit problems was tetramethylthiuram disulfide (TMTD; Thiram). This repellent was successfully tested by the Denver Wildlife Research Center by Besser and Welch (1959) and safely used to treat most nursery-grown seedlings. Although still used in soaps and lotions, use of TMTD as a forestanimal repellent has recently declined sharply because of possible neurotoxic and human exposure problems. These problems are based on TMTD's similarity to tetraethylthiuram disulfide (TETD; antibuse) used in alcoholic rehabilitation programs (Lee and Peters 1976).

Looney (1969) and Evans (1974a)Present a detailed review of forest-animal damage research in the Pacific Northwest. Briefly, the USFWS took an early lead in identifying animal problems and testing methods of control; this onset dates back to the early 1900's. In 1950, the Denver Wildlife Research Center of the FWS started researching problems in the Pacific Northwest and in 1955 established the Forest-Animal Research Project in Olympia, Washington. Shortly thereafter, the U. S. Forest Service, state forest land management agencies in Washington and Oregon, Oregon State University, and private industry all joined or subscribed support to the attack. Currently, USFWS is the only agency with full-time obligations to forest-animal damage control research; Washington Department of Natural Resources, Oregon State University, University of Washington, and Weyerhaeuser Company have only partial commitments to the problem. The Forest Service has no one committed to animal damage research.

FOREST-ANIMAL DAMAGE PROBLEMS AND CONTROL IN WESTERN OREGON: 1982-83 SURVEY OF FOREST LANDS

Current data on forest-animal problems and types of protection methods being used in western Oregon were lacking. The Cooperative Animal Damage Survey covering western Oregon, was completed in 1975 (Black et al. 1979) and only southwest Oregon has been surveyed since then, in 1980 (Evans et al. 1981). Therefore, a study was conducted in 1983 on forest-animal damage problems and their control on western Oregon forest lands planted in 1981-82 and 1982-83.

Major emphasis for the study was placed on problems and control on (1) BLM lands in western Oregon, (2) National Forests in northwestern Oregon, (3) Oregon State Forest lands, and (4) private forestry companies. These four groups were considered major users of forest protection materials.

The study consisted of a questionnaire survey, and interviews with producers, sales people, and land managers. In the survey, forest land managers were asked to list acreages being reforested in 1982 and 1983 and acreages needing protection from animals. They were also asked to identify major damage problem areas and species of animals causing damage, kinds and amounts of seedling protection materials, and other methods used for controlling wildlife damage. In addition, they were asked if cost-benefit information was obtained in 1982 or 1983. Other questions included the percentage of time that damage to plantations could be predicted, if genetically improved planting stock required protection, and where genetically improved plantations were located.

In another phase, manufacturers and distributors of seedling protection products were contacted and asked to identify major users buying their products. These users were also contacted. Information trends in kinds of products used and about development of new products was also obtained.

In addition, field plantations were examined with managers to discuss specific methods being used to protect seedlings, published and unpublished reports were obtained or discussed with investigators to help assemble information on the variety of practices and projects being carried out to reduce forest-animal problems; sites were visited independently to observe problems and attacks on problems.

Results of the Study

Coverage --Information was obtained about 97,263 acres planted in 1981-82 and from 103,270 acres planted in 1982-83 within district boundaries of the BLM in western Oregon. Based on 1980-81 figures (U.S. Forest Service 1981), this sample represents about half of the forest lands planted in all of Oregon. The data collected also represents an almost equal division of timberland ownership between public and private lands in western Oregon (Gedney 1982).

In general, BLM and Oregon Forestry ownerships were widely distributed. Forest Service and private lands surveyed were concentrated more in the northwest Oregon.

Some private ownerships combined all of their practices for all management areas into one reporting unit, while other owners reported separately for each area they managed. In total, information gathered represents more than 59 individual forest management areas.

Land being reforested and protection required.--Data from the four major user groups sampled showed that despite an economic depression in the forest industry, acreages planted increased more than 6% from 1982 to 1983 (Table 1).

TABLE 1.--Acreage and percentage being reforested, needing protection, and protected from animal damage on 59 individual forest management areas in western Oregon in 1982 and 1983

Ownership (number reporting)	Acres reforested						Percent acres reforested			
	Total		Needing protection		Protected		Needing protection		Protected	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Bureau of Land Management Resource Areas (24)	20,233	19,650	9,521	8,355	7,602	6,355	47	43	38	32
Private companies (11)	55,634	57,983	17,560	20,064	16,131	15,668	32	35	29	27
Forest Service Districts (16)	14,196	19,980	9,174	13,316	6,344	7,328	65	67	45	47
Oregon Forestry Department Districts (8)	7,200	5,657	7,114	2,733	6,731	2,631	74	48	93	47
Total	**97,263**	**103,270**	**43,379**	**44,468**	**36,808**	**31,982**	**45**	**43**	**38**	**31**

Twenty-four BLM Resource Areas accounted for about 19% of the total acreage sampled. Of the three remaining user groups, 11 private companies planted about 56% of the acreage, 16 Forest Service Ranger Districts about 17%, and 8 Oregon Forestry Districts accounted for about 7%.

Acres needing protection from animal damage amounted to about 45% of the total reforested in 1982 and 43% of the total reforested in 1983 on the ownerships sampled. The total percentage of acreage protected decreased from 38% in 1982 to 31% in 1983. Of the acreage protected, there were slight increases on private ownerships and Forest Service lands, a slight decrease on BLM lands, and a large decrease on Oregon Forestry lands. Complete acreages for each major user group needing protection are listed in Tables IA through 4A of Appendix A.

Tree species damaged.--Six species of commercially important conifers were reported damaged by animals (Table 2). The species reported also indicated a change from planting solely Douglas-fir to the planting of diverse species.

Douglas-fir *(Pseudotsuga menziesii)* was damaged on all management areas; western hemlock *(Tsuga heterophylla)*, western redcedar *(Thuja plicata)*, and ponderosa pine *(Pinus ponderosa)* were commonly damaged on others. BLM managers, along with managers of National Forests and private lands, reported an average of 20% of their areas had damage to western redcedar. Private owners reported most damage to western hemlock. BLM and the Forest Service reported damage to noble fir *(Abies nobilis)*. The Forest Service also reported damage to Sitka spruce *(Picea sitchensis)*.

Animals species causing damage.--More than 11 species of animals caused damage to conifers on BLM lands (Table 2). Damage by black-tailed deer (Fig. 1) and mountain beavers was the most common; damage by elk, hare, rabbit, and pocket gophers was also common. These same species caused problems in other ownerships.

TABLE 2.--Coniferous tree species damaged, animals causing damage, and managers ability to predict damage on some private and public forest lands in western Oregon during 1982 and 1983.

Ownership (number reporting)	Percentage of companies, districts, and areas having damage: Tree species[1] damaged	Percentage of companies, districts, and areas having damage: Animal species[2] causing damage	Ability to predict damage (%)
Bureau of Land Management	DF = 100	D = 92; Mb = 79	58
	WRC = 25	E = 54; H/R = 33	
Resource Areas (24)	PP = 21	Pg = 17; Ls = 8	
	NF = 4	P = 8; S = 4	
		M = 4; G = 4	
Private Company (11)	DF = 100	Mb = 100; D = 100	52
	WH = 37	E = 82; H/R = 64	
	WRC = 18	M = 36; P = 9	
		Pg = 9; Ls = 9	
Forest Service Districts	DF = 100	D = 88; E = 38	52
	WRC = 19	PG = 38; Mb = 25	
(16)	WH = 6		
	NF = 6		
	SS = 6		
	PP = 6		
Oregon Forestry Department Districts (8)	DF = 100	D = 88; Mb = 75	65
		E = 63; H/R = 38	
			X57

[1] DF = Douglas-fir; WH = Western hemlock; WRC = Western redcedar; NF = Noble fir; SS = Sitka spruce; PP = Ponderosa pine

[2] Mb = Mountain beaver; D = Deer; E = Elk; G = Ground squirrel; H/R = Hare/rabbit; M = Meadow mice; Pg = Pocket gopher; P = Porcupine; Ls = Livestock; S = Gray squirrel

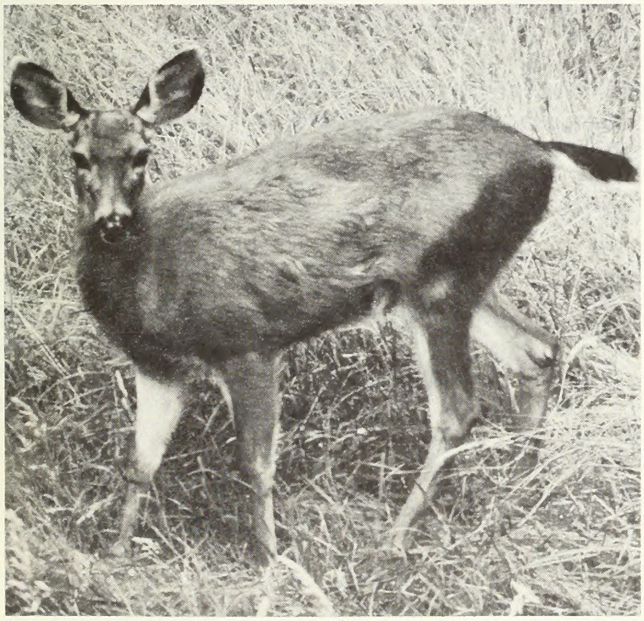
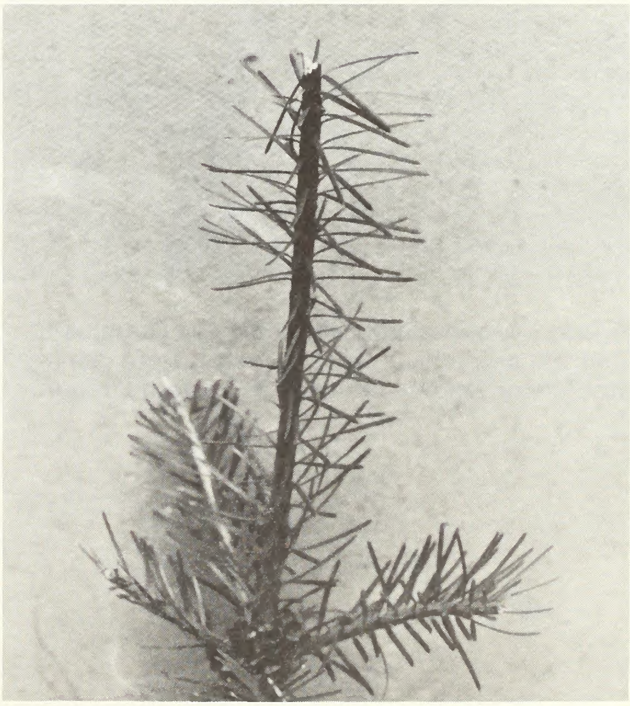


Figure 1. Black tailed deer browsing on Douglas-fir in both spring and winter was the most common damage retarding tree growth in western Oregon.



Most managers considered mountain beavers the most severe problem (Fig. 2). Mountain beaver damage ranked as the highest problem on private forest lands and second to deer on BLM and Oregon Forestry lands. Mountain beaver problems were least common on Forest Service districts and in all ownerships in the Cascade Range.

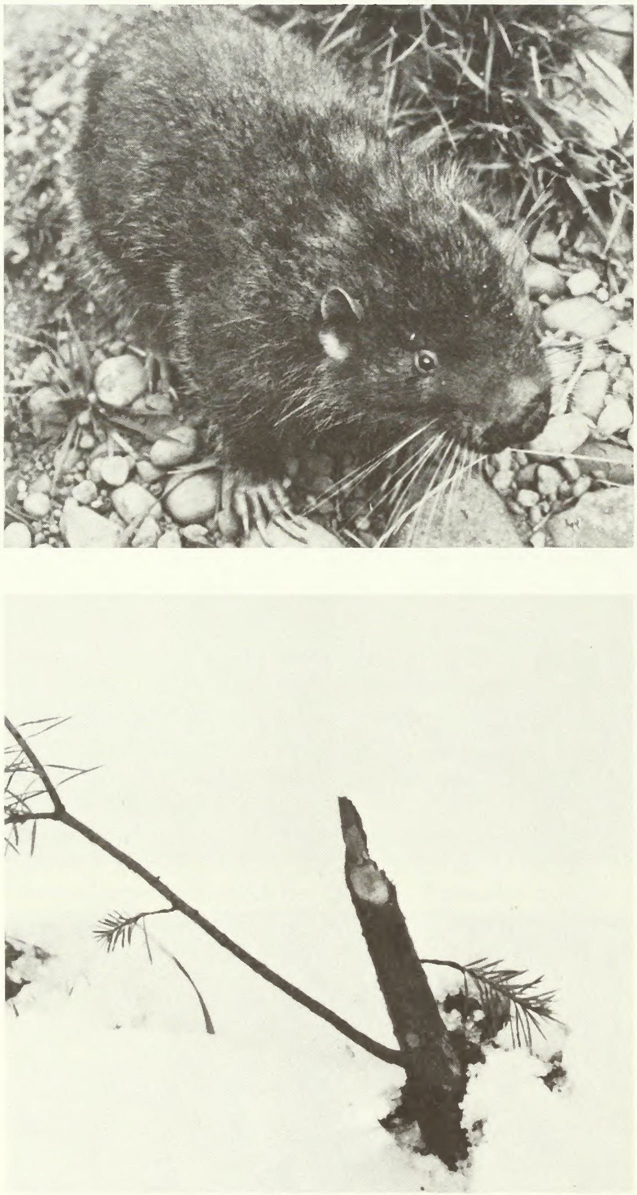


Figure 2. Mountain beaver cutting of Douglas-fir stems in all seasons was the most severe damage problem on reforested lands in western Oregon.

Elk ranked third in reported problems; they often caused more severe damage than deer. Elk damage was greatest in and along the west side of the Coast Range where it often occurred with deer and mountain beaver damage.

Snowshoe hare and rabbit damage was reported by 35% of BLM and Oregon Forestry managers and by about 64% of private managers. The Forest Service did not report hare or rabbit problems.

Some (4%) damage to trees by meadow mice (probably *Microtus townsendii*) was reported on BLM lands; substantial (36%) damage was reported by private ownerships.

Pocket gophers damaged plantations on about 17% of BLM Resource Areas. Forest Service Districts reported 38% and private ownerships 9% pocket gopher damage.

Livestock--cows (*Bos* spp.), sheep (*Ovis* spp.), etc.--was listed as one "species". Livestock problems appeared to be tolerated by managers more on public lands than on private lands.

Columbian white-tailed deer *(Odocoileus virginianus leucurus)* caused undetermined damage in the Roseburg area, and damage to a cottonwood *(Populus spp.)* plantation along the Columbia River near Westport, Oregon.

Other animals causing damage on private, federal, and state managed plantations included porcupines, western gray squirrels, and ground squirrels *(Spermophilus beecheyi)*.

Animals causing damage on particular management units are listed in Tables IA through 4A of Appendix A.

Ability to predict animal damage.--Average ability to predict animal damage as reported by managers of 24 BLM Resource Areas was 58% (Table 2). Managers of private and Forest Service lands indicated slighly lower ability to predict animal damage at an average of about 52%. Oregon Department of Forestry managers indicated slightly higher abilities (average 65%) to predict damage problems. Damage prediction for specific management areas is listed in Table IA in Appendix A.

The main criteria for predicting damage was physical evidence of animals such as obvious use of areas by mountain beaver, elk, and pocket gophers. This criteria increased the predictability of damage. Some managers predicted damage to new plantations based on damage to adjacent or nearby plantations. Poor habitat conditions were sometimes used to predict problems.

Aid by wildlife biologists increased the ability of managers to predict damage. In many areas being reforested, however, wildlife biologists were not available to help silviculturists predict damage, plan methods to avoid animal problems, or to plan and monitor effects of treatments to reduce animal problems.

Locations of damage.--General locations of heaviest animal damage and types of damage reported within western Oregon BLM districts are shown in Figure 3. Locations were partly associated with the amount of logging and reforestation being done.

Most severe animal problems were from mountain beaver, elk, and deer west of the Willamette River and along the Coast Range. Heavy deer damage also occurred in the Cascade foothills. Pocket gopher problems were most severe in the higher Cascades and southwestern Oregon on BLM and Forest Service lands. Pocket gopher damage also occurred in some coastal areas of the BLM Salem District.

Some managers reported virtually no animal damage problems to particular plantations. Reasons for the relative lack of damage in these areas was not determined.

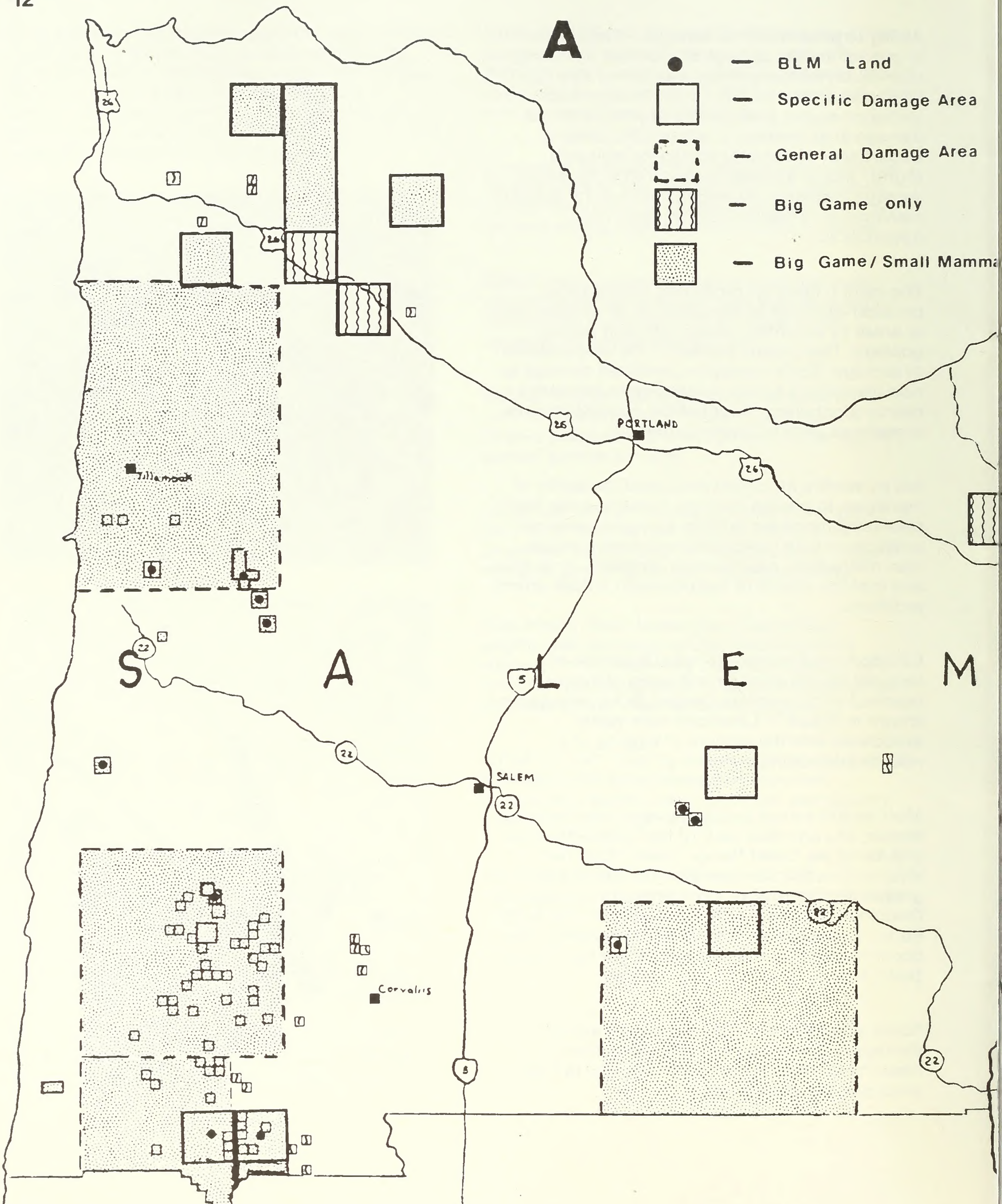
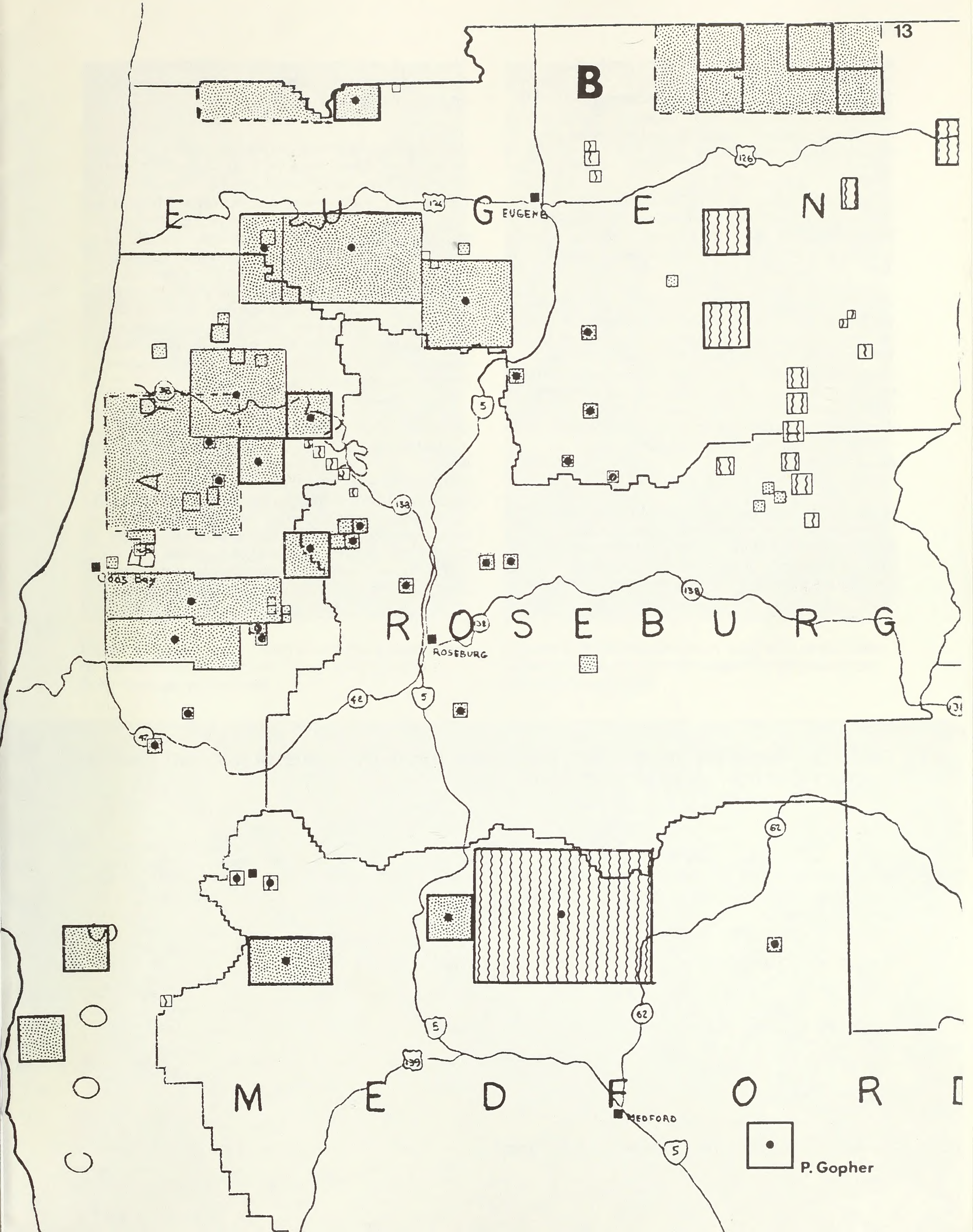


Figure 3. Public and private lands having heaviest forest-animal damage within the BLM Salem District (A), and Eugene, Coos bay, Roseburg, and Medford BLM Districts (B).


B
E U G E N E
EUGENE
126
ROSEBURG
R O S E B U R G
Coos Bay
38
138
42
5
62
199
MEDFORD
M E D F O R D
P. Gopher

Barriers.--The amount of seedling protection materials used in 1983 was similar to that used in 1982 despite poor economic conditions (Table 3). Reported amounts by ownerships and management areas are presented in Tables 5A through 8A of Appendix A.

Rigid plastic mesh tubes (Figs. 4 and 5) were the main materials used to protect tree seedlings in both years; they made up 41% of all methods used in 1982 and 44% of all methods used in 1983.

Use of rigid tubes by BLM decreased from 68% in 1982 to 62% in 1983. Comparative use showed an increase from 28% to 35% on private lands from 1982 to 1983, an increase from 42% to 66% on Oregon Forestry Districts, and no change at 39% on Forest Service lands for both years. Reasons for these changes was not obvious, however, increased availability of other methods and materials possibly influenced use on all ownerships.

Waterproof paper bud caps, intended to protect terminals for several months against deer and elk browsing, were the second most used method; they were used on about one-fourth of the plantations protected in 1982 and 1983 (Table 3). There was increased use of paper bud caps on BLM and Forest Service lands, and decreased use on private and state lands.

Use of tubular lightweight plastic netting bud caps decreased slightly from 5% in 1982 to 4% in 1983 (Table 3). The use of either 6 mil or 12 mil material for covering whole seedlings decreased from 8% in 1982 to 3% in 1983. Some managers used the lightweight netting as bud caps against deer browsing mainly in winter. Use against summer browsing decreased because of deformed seedling growth and the lack of long term protection (Fig. 6). The Forest Service was the only agency that still planned to use this netting for bud caps in northwestern Oregon; their use to protect entire seedlings was to increase while other managers indicated decreased use.

Other materials used for individual seedling protection included milk cartons supported by wooden arrow shafts, used primarily on private land, rigid plastic bud caps (Fig. 7) used on BLM lands and some private lands, aluminum foil used by one company for protection against meadow mice, Reemay[R] polyester fabric sleeves used by one BLM Resource Area and one private company, and acetate as anti-climbing devices used experimentally on Oregon Forestry land.

Table 3.--Seedling protection materials used by ownerships sampled in western Oregon in 1982 and 1983.

	Ridig plastic mesh tubes		Waterproof paper bud caps		Big Game repellent (BGR)		Thiram repellent (TMT)		Plastic netting bud caps		Plastic netting whole tree	
Ownership	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Bureau of Land Management acres	5,125	3,953	1,626	1,943	312	--	--	--	--	--	288	3
% of total	68%	62%	21%	31%	8%	5%	--	--	--	--	3%	0.1%
Private industry acres	4,560	5,505	3,942	3,073	1,860	2,085	3,636	2,995	--	--	899	555
% of total	28%	35%	24%	19%	16%	11%	23%	16%	--	--	6%	4%
Forest Service acres	2,491	2,823	1,000	1,500	832	1,472	--	--	1,725	1,183	296	350
% of total	39%	39%	16%	20%	12%	18%	--	--	27%	16%	5%	5%
Oregon Dept. of Forestry acres	2,829	1,736	2,148	733	--	--	--	--	150	0	1,600	150
%o of total	42%	66%	32%	28%	--	--	--	--	2%	0%	24%	6%
Total for acres sampled	**15,005**	**14,017**	**8,716**	**7,249**	**3,315**	**3,869**	**3,636**	**2,995**	**1,875**	**1,183**	**3,023**	**1,058**
% of total	**41%**	**44%**	**24%**	**23%**	**9%**	**12%**	**10%**	**9%**	**5%**	**4%**	**8%**	**3%**

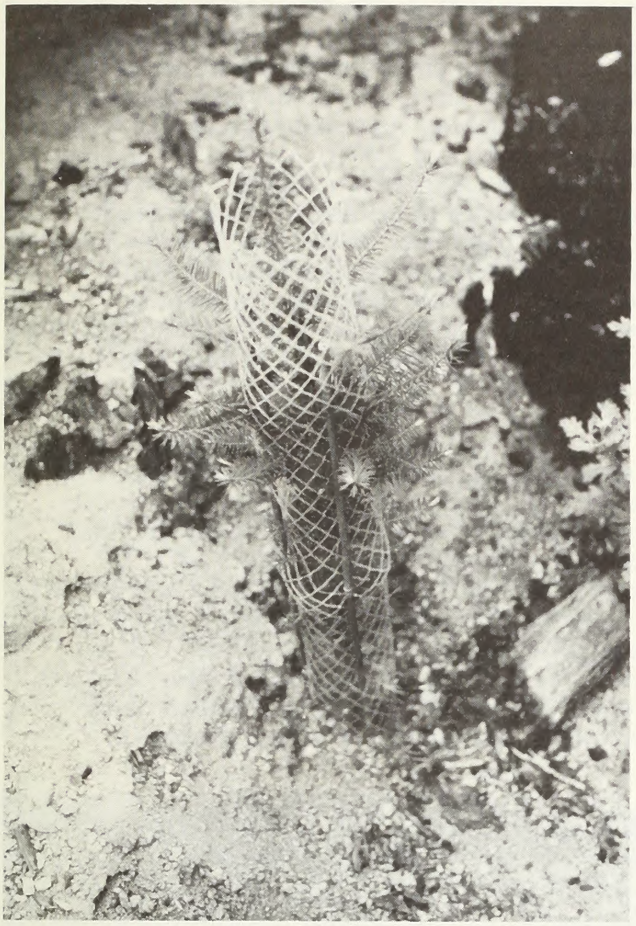


Figure 4. Rigid plastic mesh tubes, here supported by bamboo sticks, protect Douglas-fir seedling from damage by animals.

Figure 5. Rigid plastic mesh tube with small mesh openings used to protect western redcedar from damage by animals.

Milk cartons		Rigid plastic mesh bud caps		Aluminum foil wrap		Reemay fabric sleeves		Acetate climbing barrier	
1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
--	--	--	76	--	--	--	68	--	--
--	--	--	1%	--	--	--	1%	--	--
707	960	307	385	220	--	--	110	--	--
4%	5%	2%	2%	1%	--	--	0.5%	--	--
--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--
2	4	--	--	--	--	--	--	2	8
0.1%	0.2%	--	--	--	--	--	--	0.1%	0.3%
709	**964**	**307**	**461**	**220**	**--**	**--**	**178**	**2**	**8**
2%	**3%**	**0.8%**	**1%**	**0.7%**	**--**	**--**	**0.5%**	**0.1%**	**0.1%**

Repellents.--Liquid and powdered formuations of BGR[R] Big Game repellent (also registered as Deer Away[R]) were used on 9% of the acreage protected in 1982 and 12% in 1983 (Table 3). Most applications were made soon after bud burst although some users applied BGRR in winter and again in summer on the same seedlings. Most managers using BGR" did not report the specific formulation used. Data did show that use of the powdered formulation was increasing on Forest Service land.

Most users indicated difficulties in properly timing applications of BGR[R] on seedlings due to weather, bud burst, and other reasons. Applications in winter were often limited to use of the powdered formulation, usually from January to March, for adherence to wet foliage. Successful applications with spray or powder at bud burst usually were done between about May 1 and 15 to treat new foliage before it was browsed.

The long lasting repellent TMTD (Thiram, Thiuram, SCRAM[R]) having high value against hare and rabbit damage, was used on 10% of the seedlings in 1982 and on 9% in 1983 and only by private industry. One company reported extensive use of TMTD to protect small seedlings but indicated that future use would decrease as larger trees were planted. Two other companies failed to specify amounts of TMTD used in 1983. In some instances, stock treated at the nursery with TMTD was later treated in the field with other seedling protection materials. No federal or state managers used TMTD either in 1982 or 1983, primarily because of concern expressed by planting contractors. Discussion with users indicated use of TMTD would decline because of these same concerns.

Trapping.--Trapping ranked first, over hunting, baiting, and other methods of control. However, many managers expressed concern about the value of kill trapping because of rapid reestablishment of mountain beavers in previously trapped plantations. Kill trapping was extensively used for mountain beaver control on 10 BLM Resource Areas; 10 private companies, 4 Oregon Forestry Districts, and 3 Forest Service Ranger Districts also trapped for control (Table 4).

Figure 6. Plastic netting used to protect seedlings from animal damage has caused deformities in growth of Douglas fir

Trapping methods used on all ownerships were similar but intensity varied. Several managers reported that 80% of their young plantations were trapped yearly.

Many managers kept records of mountain beaver kill trapping, but records on tree seedling damage were usually limited to stocking surveys. In addition to mountain beavers, other nontarget animals such as mink *(Mustela vison)*, weasels *(Mustela frenata)*, and skunks (mainly *Spilogale gracilis*) were also caught in traps set in burrows. Few records were kept on specific changes in mountain beaver populations or damage associated with trapping.

Hunting.--Hunting seasons to control damage by deer and elk were proposed mainly by 82% of the private companies contacted (Table 4); less than 24% of the publically managed areas used hunting as a control method. Some control hunting was done for porcupine, gray squirrel, and black bear. A bounty was offered for porcupine in Douglas County.

Figure 7. A small-diameter rigid-plastic bud cap used to protect Douglas-fir seedlings from browsing by deer.

Poisons.--Most baiting was with strychnine-treated grain bait for pocket gophers on Forest Service and BLM lands in the higher Cascades (Table 4). Pocket gophers were also baited in the Coast Range where both pocket gophers and mountain beavers damaged trees at the same sites. Meadow mice were baited with zinc phosphide-treated bait inside fenced areas having high value trees. Porcupines were baited with strvchnine bait blocks in some areas having suitable "roost trees".

Fencing.--Fencing to prevent wildlife damage was not used mainly because it was incompatible with terrain, expense, and public use of the areas surveyed. Fencing against livestock damage to plantations was used in a few livestock range areas (Table 4). Seed orchards and test plantations were the only sites commonly fenced against big game and livestock. Some high value plantations that had been fenced required tubing or trapping, or baiting and herbicides or cultivation to protect against hares, rabbits, mountain beavers or voles inside the fences.

Habitat modification.--More than one-third of the BLM Resource Areas and Oregon Forestry Districts reported using habitat modification to alleviate wildlife damage to conifers (Table 4). Habitat modification included a wide variety of management practices from site preparation and vegetation control to seeding browse species.

Most seeding was done with a combination of grasses and legumes primarily for erosion control and for indirect benefits gained from improving wildlife habitat and controlling damage.

Herbicides were used to reduce cover for mammals and to control grasses which reduced tree growth. Some herbicides used for grass control stimulated forbs desirable for big game use and damage prevention. Several managers noted higher mountain beaver damage to conifers after herbicide applications had reduced other available vegetation.

Large seedlings.--Only two companies planted large seedlings to reduce animal damage (Table 4).

Genetically improved stock.--Information on genetically improved stock relationships to animal damage was generally lacking except for a few tests being conducted to determine resistance. Most plantings of improved stock of known parentage were inside fenced areas. Data on animal damage to unfenced plantings of improved stock from a private nursery was not yet available.

TABLE 4.--Trapping, hunting, and other methods used to protect forest plantations from animal damage on ownerships sampled in western Oregon in 1982 and 1983.[1]

Ownership (number) (reporting)	Trapping [2]		Hunting		Habitat modification [3]		Baiting [4]		Large tree seedlings	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
	Percent									
Bureau of Land Management Resource Areas (24)	42	42	13	17	38	38	21	17	--	--
Private (11)	91	91	82	82	27	27	9	9	18	18
Forest Service Districts (16)	19	19	25	25	13	13	31	31	--	--
Oregon Dept. of Forestry (8)	38	50	25	25	38	38	--	13	--	--
TOTAL (59)	44	46	31	32	29	29	19	19	3	31

[1]These methods were specifically listed for forest-animal damage control; most management areas also used fenced exclosures for experimental planting and a few plantations in livestock range areas were fenced.

[2]Mainly for mountain beaver.

[3]Usually associated with site preparation or vegetation control with herbicides.

[4]Mainly for pocket gophers.

Table 5.--Cost-benefit information collected on forest-animal damage control methods in 1982 and 1983.

Ownership	Percentages of management areas indicating collection of cost-benefit data			
	1982		1983	
Bureau of Land Management	5/24	21%	9/24	38%
Private Companies	6/11	56%	7/11	64%
Forest Service	6/16	38%	6/16	38%
Oregon Department of Forestry	1/8	13%	3/8	38%

Cost and benefits.--Cost-benefit information for protecting tree seedlings from animals was gathered by BLM on five Resource Areas in 1982 and nine Resource Areas in 1983 (Table 5). Private industry and the Forest Service gathered more; Oregon Forestry gathered less. In general, cost-benefit information for specific protection methods was usually unavailable because untreated (control) trees or sites were not compared with the protected trees or sites.

Moderate damage, which did not affect stocking levels, was generally tolerated by most managers. Most managers justified protection methods they used based on survival and growth of their protected plantations and knowing that losses from delays in regeneration can be substantial (Brodie and Tedder 1982). Others justified expenses where damage was severe or where animals were expected to cause understocking.

Costs for specific methods and materials used were not requested from users because of the obvious wide range of materials and technques used for each method. For example, many types of plastic mesh tubes and many installation methods were used that greatly influenced costs. Also, paper bud caps, repellent applications, trapping procedures, etc., were installed using a wide variety of application methods. Costs also varied considerably because of different labor arrangements and because of site differences. Benefits--i.e., tree survival and tree growth of protected vs unprotected stock--were generally not available.

Except for severe damage situations, most protection costs for Site III lands were estimated to be within the $152.28-per-acre average justified for protection indicated by Brodie et al. (1979).

CONCLUSIONS

Managers have few guidelines for predicting animal damage on plantations. Most initiate control programs based on their own experiences.

Economic studies show there is justification to protect forest plantations from forest-animal damage (Brodie et al. 1979). These costs, particularly for specific methods, are difficult to obtain.

In a few instances, wildlife biologists and foresters are beginning to work together to anticipate forest-animal conflicts (Michaels and Johnson 1981). However, a much broader effort is needed to properly attack the problem and to make forest-animal damage control programs more cost-effective.

GENERAL BIOLOGY OF SIX MAMMALS AFFECTING REFORESTATION ON BLM LANDS IN WESTERN OREGON

Proper identification of animals causing damage is important for controlling damage. Knowledge about these animals can aid in proper management of forest resources.

This section identifies and gives the general biology of six species of mammals that reportedly cause the most damage to conifer regeneration on BLM lands in western Oregon. The impact these species have on tree survival and growth is briefly discussed. Legal and damage status are mentioned. Biology information, in part, was taken from Ingles (1965) and from the "Animal Damage Control Handbook" (U. S. Forest Service 1978). Scientific names come from Jones et al. (1982).

Types of feeding injuries to conifers have been illustrated by Lawrence et al. (1961). Effects of damage are presented by Black et al. (1979). Information on other species can be found in publications and references given by Moore (1940), Evans (1981), and others.

Cattle, a major problem mammal in southwestern Oregon forests (Evans et al. 1981) are not discussed here. Information on cattle and other animals that conflict with reforestation can be found in Black (1969, 1974) and Black et al. (1979).

Drawings of animals were obtained from U. S. Government and State of Oregon sources.

BLACK-TAILED DEER
(Odocoileus hemionus columbianus)
Order: Artiodactyla (even-toed hoofed mammals)
Family: Cervidae (elk and deer)

Black-tailed deer are the common deer of forests in coastal Oregon. Their all black topped tails distinguish them from mule deer *(O. h. hemionus)* and Columbian white-tailed deer *(O. virginianus leucurus)*. Mule deer occur occasionally in parts of various counties in the high Cascades; Columbian white-tailed deer occur mainly near Roseburg in Douglas County and along the lower Columbia River.

Black-tailed deer prefer subclimax habitat types following logging, wildfires, and other disturbances. They commonly occur in cutover, reforested and brushy areas and along forest edges but will frequent stands of mature timber during periods of deep snow. Black-tailed deer are essentially nonmigratory, nonherding animals although some populations make seasonal shifts in range and bunch together in small bands or family groups.

Breeding takes place generally in November. One buck may serve many does. Gestation is about 207 days. Fawns, numbering from one to three per doe, are born in May and June. Bucks shed their antlers generally in January and February and begin regrowing antlers starting about April.

Deer are active day and night. They feed principally in early morning and late evening. Principal food items are succulent and woody plants including commercially valuable conifers. Conifers are browsed during both spring and winter. During spring, black-tailed deer prefer some forbs over conifers. In some locales, black-tailed deer feed heavily on grass during late winter and early spring. During winter, various shrubs and vines are preferred over conifers.

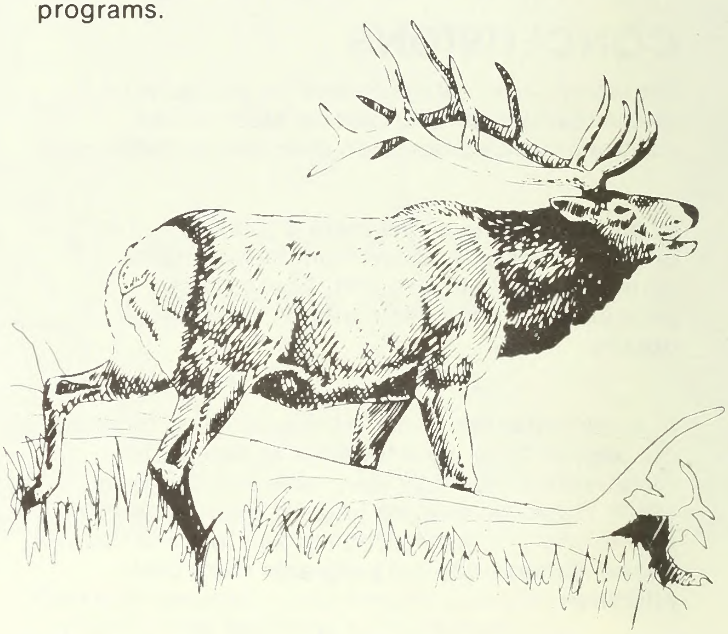
Man and nature are deers' greatest enemies. Many are killed annually by hunters, cars, and environmental factors. Coyotes *(Canis latrans)* are a major problem in some herds.

Damage: Deer browse foliage of conifer seedlings and trees, strip bark off saplings with their teeth, and rub bark off seedlings and saplings with their antlers. Browsing normally results in reduced height growth of seedlings and can lead to direct or indirect seedling mortality. Some trees can lose 5 to 10 years or more height growth that can adversely affect final timber yield. Bark rubbing and stripping appears to cause minor economic losses compared to losses caused by browsing.

Status: Deer are game animals protected and regulated by the Oregon Department of Fish and Wildlife. Browse damage by deer is the most common type of animal damage to conifers in the Pacific Northwest. It occurs virtually on all plantations.

ELK *(Cervus elaphus)*
Order: Artiodactyla (even-toed hoofed mammals)
Family: Cervidae (elk and deer)

Two elk subspecies inhabit western Oregon. The Roosevelt elk *(C. e. roosevelti)* is present throughout the area; the Rocky Mountain elk *(C. e. nelsoni)* is present in some locales. The Roosevelt elk is generally bulkier than the Rocky Mountain elk. The ranges of both subspecies is continuously expanding due to transplant and protection programs.



Large size, massive antlers, and a large whitish-yellow rump patch distinguish elk from other American deer in the area.

Except for some seasonal shifts, elk in western Oregon are nonmigratory. Small groups or large herds can be found in the same locale season after season and year after year. Mature bulls may occur singly or in small groups away from the main herd.

Elk tend to prefer coastal forests and forest openings close to cover. Riparian zones are highly preferred. Dense stands of trees and mature timber are important habitat for elk. Clearcuts and other deforested lands are used immediately after harvest. Greatest use of cutover land, however, is generally 3 to 8 years or more after logging.

Bulls breed with several cows in a harem or as part of a large herd. Breeding occurs mainly in September and October. Gestation is about 255 days. One calf is generally born to a cow about mid-May or June. Bulls shed their antlers in winter and regrow them in spring.

Elk graze grasses and sedges and browse forbs and woody plants. Certain forbs, shrubs, and conifers are highly preferred foods.

Elk are highly prized by their best friend and worst enemy--man. Substantial numbers are harvested each year. Predation by wild carnivores does not seem to be a limiting factor in western Oregon.

Damage: Like deer, elk browse young conifers during spring and winter resulting mainly in loss of seedling height growth. This growth suppression can continue for years. Elk also pull out newly planted seedlings, trample seedlings and saplings, and strip and rub bark from conifers. The impact of trampling and stripping is generally insignificant compared to that caused by feeding and pulling injuries.

Status: Elk are game animals protected and regulated by Oregon State game laws and regulations. Elk damage has increased substantially throughout western Oregon over the past few years. Pulling out seedlings by elk is becoming quite common and quite severe in some areas.

MOUNTAIN BEAVER
(Aplodontia rufa)
Order: Rodentia (gnawing mammals, rodents)
Family: Aplodontiidae (mountain beavers)

Mountain beavers are relatively large (1 kg or more), feisty, dark brown rodents with a bull neck and very short tail. They are common in coastal forests, riparian zones, and usually prefer areas with deep, rich soil. They are burrowing mammals spending much of their time underground. They can climb trees, and they are often referred to as "boomers" or "mountain boomers".

Mountain beavers are usually found in snow free areas but can also be found in snow covered forests at high elevations. They are active year round and occur in all forest types and ages. They are most abundant in brushfields, dense fern/forb areas, and other heavily vegetated forest habitats.

Mountain beavers are strictly vegetarian as they eat a variety of fleshy and woody plants. Food is carried between the teeth to an underground nest or several underground food caches. They eat most of their food underground.

Mountain beavers are solitary and rather secretive. Their presence in an area is indicated by bunches of cut vegetation outside burrow entrances, fresh burrow diggings, and damage to seedlings and saplings. They are active above ground mainly at night and occasionally during the day. They are periodically active below ground at all times.

Most mountain beavers do not mate until after they are a year old. They have a single litter per year. Breeding usually occurs in January or February. Gestation is 28 to 30 days. Three to four blind, hairless young are born per litter in March or April in an underground nest chamber. Young depend on their mothers for several weeks; they are "kicked out of the nest" in early to late summer and establish new burrow systems or renovate old, abandoned ones. Males and females usually have individual single "nests". Burrows and nests are quickly occupied by adults or young mountain beavers if the "original" mountain beaver is killed.

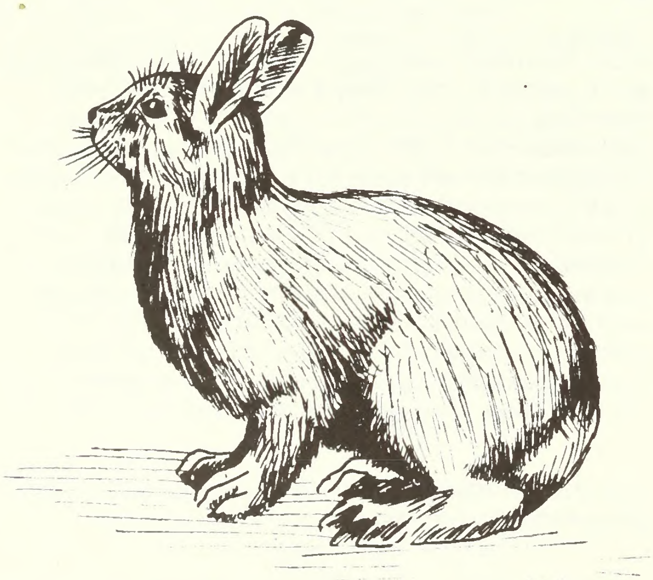
Coyotes, mustelids, hawks and owls, and bobcats are principal enemies.

Damage: Mountain beavers gnaw, cut, clip, and girdle conifers. Almost all damage is above ground, however, below-ground stem and root damage does occur. Young seedlings as well as established saplings and polesize trees are vulnerable to attack by mountain beavers. Brushy areas, deep soil riparian zones, deforested lands with or without dense slash and logging debris, as well as precommercially thinned areas, can be subject to severe mountain beaver damage. Damage occurs year round but occurs predominantly in late winter to early spring.

Status: Mountain beavers are not protected or managed by the Oregon Department of Fish and Wildlife. Because of their destructive nature and a lack of control methods, mountain beavers are considered the number one pest animal in coastal forests. They nesent a serious problem in brushfield reclamation projects and brushy reforestation units. Mountain beaver damage is on the increase in western Oregon.

SNOWSHOE HARE *(Lepus americanus)*
Order: Lagomorpha (pikas, hares, and rabbits)
Family: Leporidae (hares and rabbits)

Snowshoe hares may be found in all habitat types but are most common in cutover or naturally deforested lands with dense vegetation. They are the small, dark brown "rabbit" of northwestern Oregon forests. Their short ears and legs separate them from black-tailed jackrabbits *(L. californicus)* that also occur on forest lands in parts of western Oregon. They lack the white undertail and rusty nape of cottontail rabbits *(Sylvilagus spp.)*.



Snowshoe hares in western Oregon (and western Washington) are slightly lighter color in winter than in summer but do not turn white like snowshoe hares of Canadian and eastern forests. If hare populations in Oregon appear to fluctuate drastically in local areas, it is probably because of rapid habitat change due to silvicultural practices rather than the cyclic phenomenon noted for other hare populations.

Snowshoe hares are most active from dusk to dawn. They are rather secretive and have relatively small home ranges (less than .5 kilometers). Some hare populations exhibit seasonal shifts from one nearby location to another.

Breeding normally starts in late January or early February and extends into early summer. Gestation is about 36 days. There are two to five young per litter and two to three litters per year. First young are born about March or April. Young are born in "nests" that are mainly small depressions in the ground under vegetative cover. They are born fully furred with eyes open and are "ready to go" shortly after birth.

Hares feed on a wide variety of forbs, grasses, shrubs, and trees. Herbaceous plants are predominant food items during the spring-summer months. Woody plants and evergreen forbs are major food items during fall and winter months.

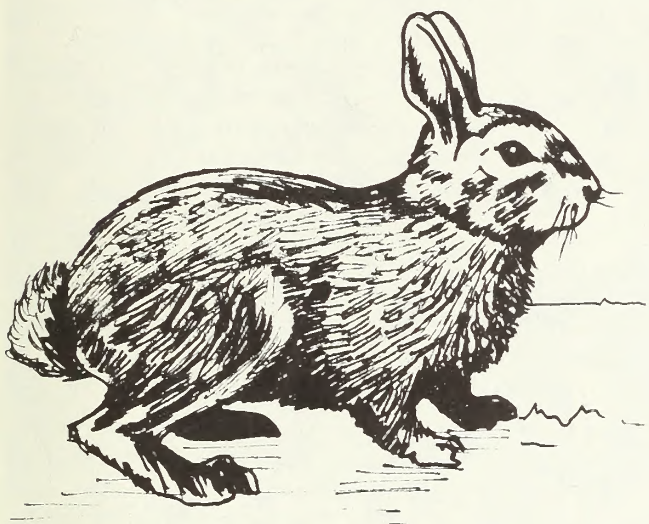
Coyotes, bobcats *(Felis rufus)*, various mustelids and a variety of hawks and owls prey on snowshoe hares.

Damage: Snowshoe hares cause damage to planted conifers by clipping the main stem resulting in seedling mortality and suppressed height growth. This damage can occur in all seasons but mainly occurs during winter months. Most damage by hares occurs the first winter after planting and can continue for several years thereafter. Small, newly planted seedlings and seedlings stunted by other animals (such as deer) are quite vulnerable to attack. Plantations with slash, brush piles, and other protective cover are particularly receptive to hare damage.

Status: Snowshoe hares are not classified as game animals or protected wildlife by the Oregon Department of Fish and Wildlife. They are hunted to a limited degree by sportsmen and varmint hunters; a hunting license is required. Some are poisoned. The snowshoe hare-reforestation conflict is a continuous and fluctuating problem. Hare damage is likely to increase in areas where burning of slash and brush piles is not permitted and on brushy sites reforested with small size planting stock.

BRUSH RABBIT *(Sylvilagus bachmani)*
Order: Lagomorpha (pikas, hares, and rabbits)
Family: Leporidae (hares and rabbits)

Brush rabbits are small, brown to brown-gray and are found only on the west side of the Cascades. The undertail of brush rabbits is white, distinguishing them from snowshoe hares. Gray bases of the white tail hairs and lack of a rusty nape separates them from the introduced and larger eastern cottontail rabbit *(S. floridanus)*.



Gestation in brush rabbits is 27 days. Breeding occurs about the first 5-6 months of the year. Each female has two to three litters each year. There are two to six young per litter. Young are born naked, blind, and helpless in shallow depressions in the ground. They remain helpless and relatively immobile for about 2 weeks.

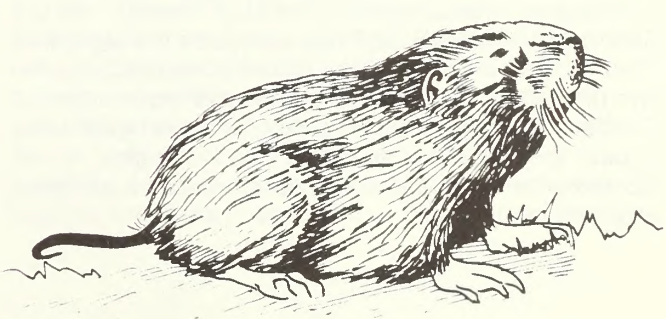
Activity, feeding habits, and enemies are similar to those of the snowshoe hare. In brief, brush rabbits are generally found in the same general locale year after year, have a limited home range, and feed on a variety of succulents and woody plants. Coyotes, bobcats, hawks, and owls are principal enemies. Seasonal shifts and population fluctuations appear to be dictated by environmental factors and silvicultural practices.

Damage: Feeding injuries to trees by rabbits and hares are similar. Most damage occurs to small seedlings. Stem clipping results in seedling mortality and reduced height growth. Some plantations may be seriously affected by rabbits while adjacent units have little or no rabbit problems. Plantations with dense slash deposits and brush piles are quite prone to damage. Brushfields, units left unreforested for several years, and understocked units requiring interplantings are most likely to have high rabbit populations and severe damage.

Status: Brush rabbits are not classified as game animals or protected wildlife. They are hunted to a limited degree by sportsmen and varmint hunters; a hunting license is required. Some are poisoned. Rabbit-reforestation problems vary according to silvicultural practices. Damage appears to be static but could increase with increased constraints on burning and brush control.

POCKET GOPHERS *(Thomomys mazama)*
Order: Rodentia (gnawing mammals; rodents)
Family: Geomyidae (pocket gophers)

The mazama pocket gopher is a small, reddish-brown to brownish-gray burrowing mammal found abundantly in Jackson and Josephine counties; it occurs also in other counties in western Oregon. Botta's pocket gopher *(T. bottae)* occurs in agricultural areas and is seldom a serious threat to forest plantations.



Gophers are generally solitary, secretive mammals that live underground. Earth mounds, plugs, winter casts, and damaged trees are usually all that identifies their presence. They occupy a wide variety of forest habitats including young Douglas-fir plantations, but are most common in forest meadows and openings as well as in idle clearcuts, shelterwoods, and other deforested areas. They are active all year. They feed on above- and below-ground portions of forbs, grasses, and woody plants. Food items are carried in cheek pouches and stored in an underground nest and nearby food cashes.

The breeding season of gophers in Oregon begins in early spring and may extend into summer. Gestation is 18 to 19 days. Females have four to eight young per litter and presumably only one litter per year. Young are generally "kicked out of the nest" in late July and August thereby accounting for a rapid expansion of populations evident by a high incidence of fresh mound building.

Coyotes, bobcats, mustelids, as well as hawks, owls, and snakes all prey on pocket gophers.

Damage: Gophers clip roots and stems of conifer seedlings and pull entire seedlings into their burrow systems. Small, newly planted seedlings are particularly vulnerable to destruction by gophers. Root pruning and stem girdling also occurs on larger seedlings and trees. Most gopher damage occurs during winter. High elevation regeneration units and mixed conifer stands incur considerable damage by gophers. Some plantations continuously lose trees to gophers for years.

Status: Pocket gophers are not protected or managed by the Oregon Department of Fish and Wildlife. Because of their widespread and highly destructive nature in reforestation, gophers are considered a major pest by the U. S. Forest Service and some BLM Resource Area managers. Clearcutting high elevation mixed conifer stands is stimulating gopher-reforestation problems in the Cascade and Siskiyou Mountains. Pocket gophers appear to be increasing in the Coast Range. Gophers have been and will continue to be a major problem in Oregon.

REVIEW OF METHODS AND MATERIALS FOR CONTROLLING FOREST-ANIMAL DAMAGE

Many methods are being tried or are being used to control forest-animal damage problems on BLM Resource Areas and other forest lands in western Oregon. Some of the methods have utility in specific problem areas or against certain wildlife species; others do not. Cost data were not requested because of the wide range of costs and methods seen in field examinations.

This section reviews chemical, mechanical, silvicultural, and biological approaches to presenting damage by animals to planted conifers. The approaches apply primarily to problems in the Pacific Northwest. Detailed information may be found in literature cited here or the papers cited by Black (1969, 1974). Some materials used in other parts of the United States and elsewhere are also reviewed because of their potential usefulness.

Manufacturers and suppliers of some of the materials mentioned are listed in Appendix B. Some of the materials being used or tested in Oregon are pictured in Figure 8.

Toxic baits.--There are several toxic baits federally registered for use mainly against forest rodents. These include grain baits treated with strychnine, zinc phosphide, 1080, or Gophacide (Evans l974a). There are also come strychnine pellets and anticoagulant baits available for experimental use and on state registration labels. Because of various mandates and regulations, only some of these can be used on forest lands. Persons planning to use toxic baits should first check with the Oregon Department of Agriculture, U. S. Fish and Wildlife Service, or Environmental Protection Agency to determine specific toxic baits permitted and restrictions or limitations on their use.

Below-ground application of strychnine grain baits for pocket gopher control is a common method used on forest lands (Barnes 1978; Barnes et al. 1980; Barnes and Anderson 1981; Crouch 1982). The bait is put into a gopher burrow system by a "gun", bait bottle, or spoon, or in an artificial burrow system made by a burrow builder-baiting machine. Strychnine is used probably more than any of the available compounds for gophers including Gophacide, a specially developed gopher bait that is still federally registered but relatively scarce. Zinc phosphide grain baits are available for use against gophers, but in eastern Oregon only, and have given poor results in recent tests (Barnes et al. 1982); these tests indicated that zinc phosphide-carrot baits showed greater potential for pocket gopher control.

Strychnine salt blocks are still registered for porcupine control. These blocks have to be placed in a tree at least 10 feet above the ground according to federal registration. The salt blocks in ground sets were effective to a limited degree for porcupine control east of the Cascade Mountains and in parts of southwestern Oregon. Studies by Dodge and Barnes (1975) in the Douglas-fir region, however, showed that porcupines seldom revisit the same locations, thus lessening the value of toxicants (or traps) for their control west of the Cascades.

A variety of baits have been tested against lagomorphs and rodents. Hooven (1977) used strychnine-treated fresh apple baits for mountain beavers and toxic tracking foam was used for controlling mountain beavers (Martin 1969; Oita 1969). Neither is currently registered for use. A strychnine pellet bait for rabbit control is registered in western Oregon.

Figure 8. Seedling protection materials used, or being tested, in western Oregon (clockwise from left--nested rigid plastic mesh tubes, tube with bamboo supports, rigid plastic mesh, bud caps, plastic netting, Big Game Repellent powder and liquid, polyester fabric, self-supporting split seedling protector, paper bud cap materials, kill trap for mountain beaver).

Recent tests with strychnine and zinc phosphide apple baits for mountain beaver control indicated possible hazards to big game (Campbell et al. l98la). Research is being carried out with prepared baits containing reserpine which is toxic and selective to mountain beavers (Campbell et al. l98lb). Reserpine, however, may not be registered for mountain beaver control, because of the high costs associated with registration procedures. Other pesticides are being scrutinized and are being used, however, use of these materials does not assure safety or efficacy.

Repellents.--Numerous chemicals have been evaluated as repellents, primarily against deer, elk, and snowshoe hares. These have included both synthetic chemicals and naturally occurring animal and plant chemicals (Evans l974a). The repellents TMTD and ZIP (zinc dimethyldithio cyclohexalamine complex) have been available since the mid-l95O's and are used as standards for comparison in many FWS repellent studies (Campbell and Evans 1977).

Until recently, TMTD (it was also called Arasan 42S, Thiram, and Scram 42S) was commonly used as a foliar repellent for hares, rabbits, and deer (Evans l974b). TMTD only offers protection to the foliage it is applied to; therefore, it should be applied to new growth. It is generally a good hare and rabbit repellent and occasionally a good deer repellent. It has limited value against other species such as mountain beaver. The registered formulation is not phytotoxic as indicated by Galt et al. (1981). Its current use is diminishing because of health-safety problems and regulations.

ZIP, previously used on Douglas-fir and pines *(Pinus spp.)*, is still federally registered as a deer-rabbit-hare repellent but is not used because of low availability.

Tests with a variety of organic decomposition products such as putrefied fish led to registration of an egg-based repellent, BGRR (Big Game Repellent; DeerAway) for foliar application for control of browsing by deer and elk (Rochelle et al. 1974; Gauditz 1976; Kastner ND). BGR powder or spray formulations are available and being used during dormant or growing seasons. It gives protection for 1 month or more. In New Zealand, repellent formulations containing egg significantly reduced browsing on pine seedlings by sheep for 3-4 months (Knowles and Tahau 1979); these authors suggest that the repellent could be used on forest sites where domestic sheep have been introduced to control noxious weeds.

These and other materials have been tested or used as repellents for forest wildlife problems elsewhere in the United States (Matschke 1980). BGR was found effective against deer when applied to preferred browse in Pennsylvania but five other repellent materials were not effective (Palmer et al. 1983). The herbicide, Kerb[R], was considered repellent to meadow voles when broadcast in a hardwood plantation in Ontario (von Althen 1979). Other standard forestherbicide formulations applied in water or diesel oil were not repellent to black-tailed deer in the Pacific Northwest (Campbell et al. l98lb). A repellent named Nivus, consisting of natural resin and thal oil, was used against winter damage by game in Russia by brushing or spraying on conifers (Ribal et al. 1977); it has not been tried in the United States.

Some synthetic repellents tested by the USFWS include coded materials referred to as DRC-3744 and DRC-2218. These are patented compounds (German Patent No. 1927640; Canadian Patent No. 851158) and have excellent repellent properties for deer, hare, mountain beaver, and several other species of wildlife. However, these compounds are not registered for use in the United States.

Generally, few synthetic chemicals will be registered as repellents for forest animal problems because of high registration costs and low economic returns to the manufacturer. Some natural compounds may stand a chance.

Natural occurring repellency, for example, is found in nontoxic plants such as wild ginger *(Asarum caudatum)* but material for commercial use is not readily available (Campbell and Bullard 1972; Hartwell 1975). Strong taste repellency from foxglove *(Digitalis purpurea)* has occurred in limited testing on naive elk and hares (FWS, Olympia, Washington, data on file) but the cause for continued rejection of this common toxic plant is unknown; the rejection could be associated with digitoxin that causes anorexic effects reducing further food consumption as noted by Meehan (1975). By contrast, tansy ragwort *(Senecio jacobaea)*, another toxic plant growing in forest clearcuts, has caused poisoning in a variety of animals (Miranda et al. 1980), but has limited repellency potential against forest wildlife.

A variety of systemic chemicals which resulted in Douglas-fir foliage being toxic and repelling to target animals have been tested by the USFWS (Kverno 1960). These soil-applied chemicals were found to be hazardous to wildlife and were never registered.

Recently, selenium was tested by the University of Washington as a systemic repellent for soil treatment for protection of Douglas-fir against deer browsing (Gustafson 1983; Allan et al. 1984). Selenium appears to be an essential micronutrient for animals but has also long been recognized as a toxic element causing poisoning in animals (Radeleff 1964). In Denmark, selenium was applied in detergent to barley crops to be fed to livestock (Gissel-Nielsen 1981); despite an LD^{50} of 2.5 mg/kg, there was no apparent mortality or environmental hazard from 100 g SE/ha/yr. However, there is evidence that selenium will cause birth defects to birds and mammals (Kingsbury 1964). The effects from selenium from coal sludge is a particular concern (Menzie 1980). The future of selenium as a repellent is unknown.

A group of plant chemicals called bitter sesquiterpene lactones are known to repel insects and mammals. One of the compounds in the group called Glaucolide-A, found in vernonia *(Vernonia spp.)* plants, has shown repellency to cottontail rabbits *(S. floridanus)* and white tailed deer *(0. virginianus)* (Burnett et al. 1977). These materials have not been evaluated in the Pacific Northwest.

Naturally occurring chemicals in conifers may also contain materials that repel animals or affect consumption. Nursery-grown stock is usually considered more subject to animal damage, but the difference in damage to newly planted or established seedlings of similar size and accessibility is often negligible. True firs *(Abies spp.)* and western hemlock are generally damaged less than Douglas-fir by snowshoe hare and deer. Western redcedar is usually highly palatabile and quite seriously damaged.

Odors secreted by animals are other possible sources of repellent chemicals. A pheromone produced by the metatarsal gland of black-tailed deer was determined to be an alarm or "fright odor" by Quay and Muller-Schwarze (1970). However, pheromones as repellents were short lived (Rochelle et al. 1974). To date, no fright producing chemicals have been registered for forest use.

Cages and fences.--Wire cages and a variety of fences have been used for years to protect forest crops from animals in the Pacific Northwest. Large diameter wire and plastic mesh cages have also been recommended to prevent deer damage in Pennsylvania (Marquis 1977).

Large diameter wire cages have been effective but are generally considered too expensive and have allowed dense vegetation growth inside the cage which in turn slows the growth of protected trees (Black et al. 1979). Still, protected trees generally outperform unprotected trees. A study by Hahn (no date), for example, showed that after 14 years, cage-protected trees produced 422 cubic feet/acre volume while uncaged trees produced 160 cubic feet/acre volume. Study of similar test trees for 16 growing seasons on BLM land indicated that cage trees produced 20% more volume than uncaged trees (Batdorff and Fauss 1981).

Properly constructed woven wire fences keep out big game and livestock. Nylon fencing has also been used. These fences, however, have seldom effectively kept out rodents or lagomorphs and cannot exclude grouse. Fenced plantations must be continuously maintained and separate control measures must often be used to reduce damage inside the fenced sites.

Recently, electrically charged wire fences have shown value against hardwood damage by deer in the east (Brenneman 1982). It is doubtful that electrical fences will be practical in the veriable terrain normally occurring in the Pacific Northwest.

Plastic and paper seedling protectors.--Since the time of the original Vexar[R] seedling protector (Campbell and Evans l975a), plastics have become widely used as barriers to protect seedlings from a variety of animals including deer, elk, hare, rabbits, mountain beaver, and pocket gophers (Borrecco 1976; Borrecco and Anderson 1980; Anthony et al. 1978; Hartwell and Calkins l978a, l978b; Baer 1980; Crouch l98Oa). Seedling protectors were the most common control measure used against black-tailed deer in California (Anonymous l982a) and have been used successfully against mule deer *(O. hemionus)* in eastern Oregon (Anthony 1982). Sturdy protectors have also been effective against livestock.

Numerous modifications have been made to meet specific local needs and to reduce costs. Changes have included nesting tubes to improve packaging and handling as well as design changes. The Nalle protector, one that looks like a Vexar tube, was also manufactured and extensively used for a short time but is no longer available.

Tubes are supported by wooden stakes, wire anchors, or imported bamboo. Some are supported by the soil. Against pocket gophers, pines have been completely encased and their roots prepackaged with soil and planted in an auger hole (Anthony et al. 1978).

Different mesh designs and sizes of tubes are available and manufactured upon request (Appendix B). The variety of materials and operational methods used have created differences in costs and effectiveness (Larson et al. 1979; Makey 1981). Some materials have not broken down as predicted (Anonymous l982b), however, resistant materials do not have to be removed from the tree (Campbell and Evans l975a). The majority of tubes currently being used are about 3 inches in diameter and 24 to 30 inches tall (Fig. 8). They are shipped nested one inside the other, usually five or ten to a pack (Fig. 8). Tubes less than 18 inches long are also used but are seldom of value except for preventing rodent damage to the base of tree seedlings or when used as bud caps where rodent problems are not severe.

Mesh diameter problems still occur. Seedling terminals grow through large mesh openings, particularly if protectors become tipped. Preloaded trees in small diameter, small mesh opening tubes that split down the side to allow tree expansion are being tested to overcome some of these problems (Fig. 8).

When other damage is not involved several types of bud caps have been used to protect the tree terminal against deer browsing. Waterproof paper bud caps are available as staple-on sheets or preglued cylinders (Fig. 8). Most users prefer making their own tubes from less expensive paper sheets. Bud cap materials have included plastic sheets (Hines 1971). Sand paper strips effective against deer in Bulgaria (Botev and Ronkov 1973) have apparently not been tried in the United States.

Bud cap installation methods vary. Most managers use the seedling terminal to support paper caps. Others install paper caps on stakes driven beside trees. Some users fold the caps over the stems and secure them with staples, however, mold may grow inside the caps. The manufacturer of waterproof paper recommends using two staples to form a cylinder and one staple along the base near the tree stem to secure it to the seedling. The openings at the lower end and top end of the bud cap allows sufficient air movement to prevent mold.

Various lightweight plastic netting (Fig. 8) were used extensively for a few years because costs were low. Lack of protection, coupled with tree deformity problems caused a sharp decline in their use after only a few years.

Reemay[R] polyester fabric tubes (Fig. 8) and other barrier materials were recently tested on Douglas-fir against deer in western Oregon (DeYoe and Schaap 1982), however, DeYoe (1983) indicated they were effective against deer browsing but caused substantial seedling mortality. Results from testing Reemay have varied in Washington (Harry Hartwell, personal communications). Rigid Vexar tubes for leader protection are preferred in the North Umpqua Resource Area of the Roseburg BLM District (John Patrick, personal communications). In Forest Service studies, first-year survival for rigid Vexar tubing was 18% higher than for unprotected seedlings (William Stein, personal communications). Bunker (1983) suggested that shade cards may reduce deer browsing. Helgerson (1983) reported on a BLM study suggesting paper bud caps were better than staked Vexar tubes and black netting which deformed trees.

Plastic protective materials have also been tested on hardwoods, and some may be useful on hardwood plantations in Oregon. Several Vexar materials have been used to protect hardwood species in the southeastern United States (Lasher and Hill 1980). Translucent plastic shelters were recommended in Great Britain (Tuley 1983), but about half of the tree stems grown in the translucent shelters were incapable of self-support because of a greenhouse effect and required tying to stakes.

Milk cartons have been used as barriers for protecting the base of hardwoods and conifers against rodents in western Oregon. Expandable aluminum shields also offer protection, particularly against basal bark removal of saplings and polesize trees by porcupines and gophers; these devices have been used successfully in California.

Trapping and hunting.--Trapping and hunting are common direct control methods. To be successful these methods must lower a pest population to a level where damage is reduced to tolerable limits. The Macabee kill traps have been effective for controlling gophers on Christmas tree farms and small reforestation units with low gopher populations (Barnes, personal communications; Crouch and Franks 1979). Conibear Model 110 kill traps (Fig. 8) are commonly used for controlling mountain beavers (Northwest ForestAnimal Damage Committee 1979; Motobu et al. 1977). Trapping of mountain beaver, however, has not been effective for long term reduction of damage on large areas or on areas where there is relatively large populations of mountain beavers. Steel leghold, traps are also used for trapping porcupines and other species, but have not always been effective and are not selective (i.e., they do not always get the target pest species). Leghold traps are also being scorned by the general public, particularly in Oregon.

Livetrapping or live capture with tranquilizers, rather then shooting, poisoning, or kill trapping, are preferred methods of removing pest species such as rabbits and hares from tree nurseries, porcupines and squirrels from tree seed orchards, or bears from sensitive areas such as city watersheds. In certain situations, livetrap removal is biologically effective. Its greatest value is that in most situations it is socially acceptable.

Hunting is another direct control method that has been used with various degrees of success. It is selective (i.e., it gets the target pest species) and can be effective. It assumes, however, that all individuals are causing damage. Hunting porcupines with a dog or on snow has been recommended by Dodge and Barnes (1975) for controlling damaging individuals west of the Cascades. Special deer and elk hunts have had variable success in reducing damage (Ives 1969) but may be effective in particular areas (Crouch l98Ob). Direct control of black bear through sportsmen hunting programs (Poelker and Hartwell 1973) has been effective in reducing bear populations and damage in Washington. However, bear hunts are being opposed by several environmental groups. In Oregon, control hunt requests are made to the Department of Fish and Wildlife.

Scare devices.--Noisemakers, firecrackers, records, CO^2 guns, silent electromagnetic devices, controclusive magnetism, as well as guard dogs and people guarding newly reforested sites have been tried to scare wildlife in order to reduce feeding injury to conifers. None have proven effective over the long run. Testimonies have claimed sonic and ultrasonic noises to be effective for repelling deer and other species, but none have been adequately evaluated in forest conditions.

Silvicultural methods.--Normal silvicultural practices can minimize wildlife damage to reforestation. Shelterwood cutting and underplanting shelterwood units for example, reduced pocket gopher damage to pine plantations in eastern Oregon (Barnes 1974) but not deer damage in southwest Oregon (Evans et al. 1981). Removing slash and brush by burning and by scarification and planting immediately afterward have been methods used to alleviate certain animal problems (Borrecco 1976). This "clean-forestry, rapid-reforestation" method has been one of the main methods minimizing damage from hares and rabbits in western Oregon and Washington. There is, however, no clear effect of slash disposal on subsequent use of plantations by elk and deer (Campbell 1982). Contrary to this, piling slash and planting small, containerized stock have renewed hare/rabbit problems in many areas and may stimulate damage by other species.

Mountain beavers are also affected by site preparation, mainly by temporarily depleting cover and food supplies and by destruction of burrows. Scarification destroys many mountain beaver burrows and helps reduce reoccupancy, particularly when piles of soil mixed with debris are leveled. Slash burning (Motobu et al. 1975) has also helped reduce mountain beaver populations for short periods.

Use of herbicides has been shown to reduce pest populations of forest gophers in mixed conifer forests by reducing vegetative cover (Black and Hooven 1977). Fall treatment with atrazine herbicide reduced pocket gopher activity and improved tree survival (Crouch 1979). However, reducing wildlife foods by spraying herbicides to rid an area of animals is not always successful. In the Douglas-fir region, for example, herbicide use can reduce the abundance of food plants normally eaten by wildlife and may increase wildlife feeding pressure on tree seedlings (Morris 1981). Campbell et al. (l98lb) found that standard herbicide formulations applied to Douglas-fir did not prevent browsing of treated plants by deer except when glyphosate caused phytotoxicity.

Planting large seedlings also appears to have value in reducing damage by some wildlife species. Smaller seedlings are usually more vulnerable to animal damage. A recent report by Hartwell and Johnson (1983) comparing 2-0 and 3-0 seedlings for 6 years after planting indicated that the 3-0 seedlings were resistant to deer and hare but not to mountain beaver. Anderson (1975) also found large stock was damaged by mountain beaver. Most forest nurseries now produce tree seedlings larger than they did several years ago. Use of these large seedlings should help minimize damage and overcome competition from other vegetation in many areas of western Oregon. However, all sizes of fast growing containerized seedlings may be more vulnerable to damage their first year after outplanting.

In summary, numerous silvicultural methods have been tried and found to be effective in reducing forest-animal damage problems in particular geographical areas, but no one method will work in all forest types.

Biological control.--There are few biological control methods available to alleviate wildlife-reforestation conflicts. Providing abundant forage to black tailed-deer more palatable than Douglas-fir has reduced spring damage in western Washington (Campbell and Evans 1978). These forbs were not competitive with Douglas-fir on plantations in western Oregon and Washington. Natural abundance of these forbs were seldom adequate to provide forage needed to prevent browsing in May and June in new plantations (Campbell and Evans 1975b; Evans et al. 1981; Kastner ND) so they were artificially seeded. Since then, the Oregon Forest Protection Association (OFPA merged July 1, 1983 with the Oregon Forest Industries Council) has funded production of native forb seeds for test plots (Dave Jessup, personal communications) based upon procedures described for obtaining these seeds for native stands (Campbell and Johnson 1981). Seeds of some preferred plants are now available (Appendix B).

In other studies, Klingler (1982) indicated there was less conifer browsing by deer in grass-legume seeded plots than unseeded plots. Miller and Zalunardo (1979) also found that several test sites seeded with legumes resulted in well stocked Douglas-fir stands over a 9-year period and indicated potential for these N-fixing plants to increase conifer growth. However, much information is still needed on beneficial and detrimental effects of nitrogen fixing plants on forest environments (Haines and DeBell 1980). Our observations of a naturally seeded forb-legume plantation in the Tillamook Resource Area, BLM, indicated good potential for reducing damage and producing good tree growth. Improved seedling establishment by covering seeds of browse plants and Douglas-fir with soil was reported by Campbell (1982).

Forage seeding for elk in clearcuts likely to have little browse (Fig. 9) was done by the Oregon Department of Fish and Wildlife as early as 1950 and still continues in western Oregon (Peterson et al. 1981; Bert Cleary, personal communications). Fortunately, forage problems in western Oregon have not become as severe as European areas where one-third of the diet of red deer *(C. elaphus)* consisted of fir browse and bark (Jamrozy 1980) and where silage was fed to reduce damage (Ueckermann et al. 1977).

Competition among foraging animals can increase damage to trees by reducing availability of preferred food plants. Livestock grazing of preferred forage causing increased damage by wildlife has been noted in southwestern Oregon (Evans et al. 1981; Stein 1981) and in northwestern Oregon. Spring livestock grazing also reduced available winter forage for elk in southeastern Washington (Skovlin et al. 1983) and may have similar effects on elk forage in Oregon.

The species of plants to be seeded for forage should be carefully considered to assure good palatability at certain seasons and to avoid competition with forest trees. In the Oregon Coast Range, Klingler (1982) noted that trees on unseeded plots had better growth and recommended that competitive grass-legume mixtures be limited to areas with high moisture. In northern Idaho Douglas-fir plantations, Eissenstat and Mitchell (1983) found that moisture available to trees was significantly reduced on grass-clover seeded sites and caused significant reduction in diameter, shoot growth, and seedling heights. The authors noted that douglas-fir seedling diameter appeared to be a sensitive indicator of plant competition.

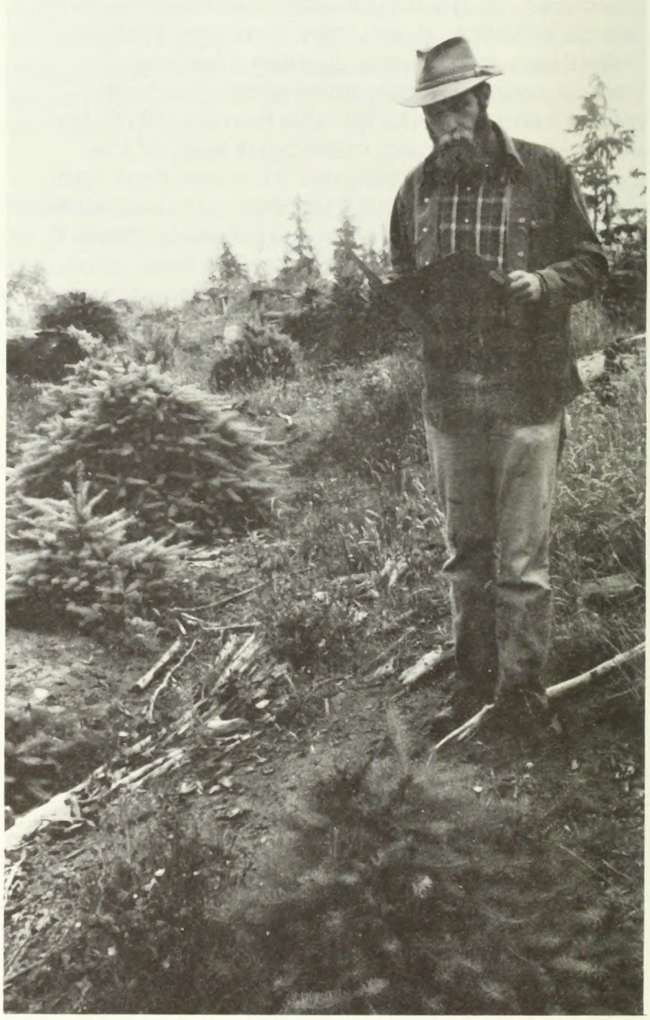


Figure 9. Big game browsing on Douglas-fir seriously retards growth on heavily used areas lacking adequate amounts of other forage plants.

The resistance of plants to animals has been recognized for many years but only recently applied to forest-animal problems (Radwan)972, 1974). Dimock (1974) and Dimock et al. (1976) found Douglas-fir clones resistant to black-tailed deer and snowshoe hares. Silen and Dimock (1978) discussed the potential for utilizing genetically resistant Douglas-fir in reforestation. Recently, Bill Randall and Roy Silen (personal communications) made further tests of clones that indicated genetic resistance. These "resistant" trees are damaged more slowly than the nonresistant ones. The resistance may be associated with lower chlorogenic acid content in the foliage (Radwan 1972; Tucker et al. 1976; Radwan and Crouch 1978). These and other studies on genetic resistance (Dickmann 1978; McNamara 1979; Bryant 1981) indicate that planting seedlings that are resistant to animal feeding pressures combined with direct seeding of noncompeting native forage for wildlife may alleviate reforestation damage (Campbell and Evans 1978).

Predation is another biological method favored by the public; but usually resulting in unmeasured effects on prey populations or damage to conifers. In many cases, a moderate change in the number of mammals feeding on trees generally will not change the amount of damage to trees, and predators normally cause only moderate changes in prey populations by killing inexperienced or displaced animals. This has been noted for several species. For example, when slash is burned, mountain beavers become more available to predators (Motobu et al. 1975) but only for a short time until vegetation recovers. Snowshoe hares move quickly from vegetation killed by frost, but mainly only young hares are killed by great horned owls *(Bubo virginianus)*, their major predator in western Washington (USFWS, Olympia, WA, unpublished data on file). A trapping ban on predators in western Oregon appeared to have little effect on mountain beaver damage despite mountain beavers being a major food item of bobcats *(Felis rufus)* (deCalesta and Witmer 1983). Predator management through habitat management may help reduce the amount of damage caused by rodents and hares or rabbits. Encouragement of suitable sites for raptors along clearcuts may help reduce numbers of damaging mammals. Bruce et al. (1982) found remains of mountain beavers and snowshoe hares in nests of golden eagles *(Aquila chrysaetos)* located near clearcuts. Other raptors and carnivores may be encouraged to hunt new clearcuts if proper habitat is available.

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APPENDIX A

Table 1A.--Approximate amounts of protection needed, animals causing damage, and predictability on Bureau of Land Management Resource Areas in 1982 and 1983.

District/ Resource Area	Number of acres needing protection 1982	1983	Percent of acres reforested needing protection 1982	1983	Animals causing damage[1]	Estimated ability of managers to predict damage (%)
Coos Bay:						
Loon Lake	2,559[2]	2,200[2]	100	100	D, E, Mb	80
Coos River	600	450	79	90	E, Mb	80
Myrtlwood	350	350	70	88	E, D, Mb[3]	80
Burt Mtn.	170	160	24	32	D, E, Mb[3]	80
Smith Umpqua	211	150	45	25	Mb, E, D[3]	80
Medford:						
Klamath	1,500[2]	1,500[2]	100	100	Pg, P	80
Rogue River	350	400	54	62	D, Pg3	80
Glendale	200	200	27	33	D, E	40
Grants Pass	200	150	25	13	D, Mb, Pg, H/R	80
Galice	0	0	0	0	D, E, Mb	40
Butte Falls	0	0	0	0	D, E, Pg, H/R, S	10
Eugene:						
Mohawk	1,200	800	100	100	D, Mb	80
Lorane	300	300	30	30[4]	D, Mb, M	40
Noti	190	250	16	25	D, E, Mb, H/R	40
Dorena	120	120	12	12	D, Mb	40
Salem:						
Alsea	300	300	40	35	D, E, Mb	10
Tillamook	213	150	20	17	Mb, D, E[3]	60
Clackamas	150	150	16	19	D, E, Mb	40
Yamhill	100	100	14	14	D, Mb, H/R	60
Santiam	0	50	0	6	D, Mb, H/R	40
Roseburg:						
North Umpqua	543	300	41	30	D, Mb, H/R	40
Drain	200	200	32	31	D, E, Mb, H/R, Ls	80
South Umpqua	75[4]	75	6[4]	6	D, Mb, H/R, G, Ls, P	40[3]
Dillard	0	0	0	0	D, E, P	80

[1] Mb = Mountain beaver; D = deer; E = elk; H/R = Hare/rabbit; M = meadow mice; Pg = pocket gopher; P = porcupine; Ls = livestock; S = gray squirrel; G = ground squirre

[2] Acreage needing protection exceeds acreage being reforested.

[3] Listed by order of importance.

[4] Estimated

TABLE 2A.--Approximate acreages that need protection from animal damage on 11 private forest industry ownerships in 1982 and 1983.

Company	Number of acres needing protection		Percent of acres reforested needing protection		Animals causing damage[1] (most to least)	Estimated ability of managers to predict damage (%)
	1982	1983	1982	1983		
A	5,965	5,743	47	60	D, E, H/R, Mb	42
B	2,621	3,549	45	51	Mb, E, D, H/R, M, P	42
C	3,474	3,500	41	48	Mb, D, E, H/R, Ls	60
D	922	1,346	13	15	D, E, Mb, Ls	42
E	1,296	1,250	85	93	D, Mb, E, H/R, M	52
F	648	1,225	39	36	Mb, E, H/R, D	80
G	1,298	1,159	28	25	Mb, D, E	53
H	623	849	26	35	D, Mb, H/R, M	50
I	812	691	12	9	Mb, E, D	56
J	400	400	20	20	Mb, Pg, D, E, M, H/R	80
K	401	352	9	8	Mb	10

[1] Mb = mountain beaver; D = deer; E = elk; H/R = hare/rabbit; M = meadow mouse; Pg = pocket gopher; P = porcupine; Ls = livestock

TABLE 3A.--Approximate amounts of protection needed, animals causing damage, and predictability on Forest Service Ranger Districts in 1982 and 1983.

Forest/ District	Number of acres needing protection		Percent of acres reforested needing protection		Animals causing damage[1]	Estimated ability of managers to predict damage (%)
	1982	1983	1982	1983		
Siuslaw:						
Mapleton	1,800	1,200	97	100	D, E, Mb	40
Alsea	1,500	750	100	100	Mb, D	80
Waldport	550	500	100	100	E, Mb, D, H/R	80
Willamette:						
Rigdon	600	1,722	26	77	D, E, Pg	60
Blue River	1,000	1,500	50	100	D, Pg	80
Oakridge	1,000	1,000	67	40	D, E	40
Lowell	900	700	69	100	D, E	80
McKenzie	195	500	28	63	D, E, Pg	40
Sweethome	208	390	19	43	D	80
Detroit	350	100	37	6	D, Pg	10
Mt. Hood:						
Barlow	633	4,086	44	100	Pg	40
Clackamas	112	409	9	13	D	40
Columbia Gorge	326	333	100	100	D, Mb	40
Zig Zag	0	104	0	41	D	40
Bear Springs	0	80	0	5	Pg	40
Estacada	0	46	0	3	D	401

[1] Mb = mountain beaver; D = deer; E = elk; H/R = hare/rabbit; M = meadow mouse; Pg = pocket gopher; P = porcupine; Ls = livestock

TABLE 4A--Approximate amounts of protection needed, animals causing damage, and predictability on Oregon State Forestry Department Districts in 1982 and 1983.

District	Number of acres needing protection 1982	Number of acres needing protection 1983	Percent of acres reforested needing protection 1982	Percent of acres reforested needing protection 1983	Animals causing damage[1]	Estimated ability of managers to predict damage (%)
Coos Bay	1,680	800	99	100	Mb, E, D	80
Tillamook	900	500	70	80	MB, H/R, E	80
Astoria	1,800[2]	500	100	42	D, E, Mb, H/R	40
Forest Grove	400	400	53	50	D, E	80
Santiam	150	200	17	29	D, Mb	40
Philomath	85	190	20	25	D, Mb	80
Veneta	299	72	91	18	D, E, Mb, H/R	80
Grants Pass	0	71	0	35	D	40

[1] Mb = mountain beaver   H/R = hare/rabbit

D = deer   E = elk

[2] Another 1,800 acres previously reforested also needs protection.

Table 5A.--Acreages and percentages of seedling protection materials used on Bureau of Land Management Districts in western Oregon in 1982 and 1983.

District	Rigid plastic mesh tubes 1982	Rigid plastic mesh tubes 1983	Waterproof paper bud caps 1982	Waterproof paper bud caps 1983	Big Game repellent (BGR) 1982	Big Game repellent (BGR) 1983	Rigid plastic bud caps 1982	Rigid plastic bud caps 1983	Remay fabric sleeves 1982	Remay fabric sleeves 1983	Whole tree netting 1982	Whole tree netting 1983
Roseburg	818	490	--	--	--	--	--	--	--	--	--	--
	100%	100%	--	--	--	--	--	--	--	--	--	--
Coos Bay	3,501	2,615	389	662	--	--	--	--	--	--	--	3
	90%	79%	10%	20%	--	--	--	--	--	--	--	1%
Medford	355	391	26	160	--	--	--	--	--	--	228	--
	42%	71%	31%	29%	--	--	--	--	--	--	27%	--
Salem	416	324	77	198	21	--	--	76	--	--	--	
	81%	54%	15%	33%	4%	--	--	13%	--	--	--	--
Eugene	35	54	1,134	923	602	312	--	--	--	68	--	--
	2%	4%	64%	68%	34%	23%	--	--	--	5%	--	--
TOTALS	**5,125**	**3,953**	**1,626**	**1,943**	**623**	**312**	**--**	**76**	**--**	**68**	**228**	**3**
	68%	**62%**	**21%**	**31%**	**8%**	**5%**	**--**	**1%**	**--**	**1%**	**3%**	**0.1%**

Table 6A.--Acreages and percentages of seedling protection materials used on private industry lands in western Oregon in 1982 and 1983.

Company	Rigid plastic mesh tubes		Waterproof paper bud caps		Thiram		Big Game Repellent (BGR)		Milk cartons		Whole tree netting		Rigid plastic bud caps		Aluminum foil wrap		Reemay fabric sleeves	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
A	1,563	1,575	1,911	1,750	--	--	--	--	--	--	--	175	--	--	--	--	--	--
	45%	45%	55%	50%	--	--	--	--	--	--	--	5%	--	--	--	--	--	--
B	--	--	200	225	3,636	2,995	400	250	--	--	101	1	--	25	--	--	--	--
	--	--	5%	6%	84%	86%	9%	7%	--	--	2%	0.1%	--	1%	--	--	--	--
C	883	1,100	--	50	--	--	600	880	700	960	137	200	300	360	--	--	--	110
	38%	31%	--	1%	--	--	26%	25%	30%	27%	6%	6%	13%	10%	--	--	--	3%
D	428	870	13	--	--	--	450	480	--	--	--	--	--	--	--	--	--	--
	48%	64%	1%	--	--	--	51%	36%	--	--	--	--	--	--	--	--	--	--
E	--	--	791	--	--	--	--	--	--	--	275	--	--	--	220	--	--	--
	--	--	61%	--	--	--	--	--	--	--	22%	--	--	--	17%	--	--	--
F	438	970	--	--	--	--	210	255	--	--	--	--	--	--	--	--	--	--
	68%	79%	--	--	--	--	32%	21%	--	--	--	--	--	--	--	--	--	--
G	195	100	917	900	--	--	--	7	--	14	--	--	--	--	--	--	--	
	17%	10%	80%	90%	--	--	--	--	1%	--	1%	--	--	--	--	--	--	--
H	--	--	70	148	--	--	--	20	--	--	54	180	--	--	--	--	--	--
	56%	42%	--	--	--	6%	--	--	44%	52%	--	--	--	--	--	--		
I	492	690	--	--	--	--	--	--	--	318	--	--	--	--	--	--	--	
	61%	100%	--	--	--	--	--	--	--	--	39%	--	--	--	--	--	--	--
J	160	200	40	--	--	--	200	200	--	--	--	--	--	--	--	--	--	--
	40%	50%	10%	--	--	--	50%	50%	--	--	--	--	--	--	--	--	--	--
K	401	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	100%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Totals	**4,560**	**5,505**	**3,942**	**3,075**	**3,636**	**2,995**	**1,860**	**2,085**	**707**	**960**	**899**	**555**	**300**	**385**	**220**	**--**	**--**	**110**
	28%	**35%**	**24%**	**20%**	**23%**	**19%**	**12%**	**13%**	**4%**	**6%**	**6%**	**4%**	**2%**	**2%**	**1%**	**--**	**--**	**0.7%**

Table 7A.--Acreages and percentages of seedling protection materials used on three National Forests in western Oregon in 1982 and 1983.

National Forest	Rigid plastic mesh tubes		Waterproof paper bud caps		Big Game Repellent (BGR)		Plastic netting bud caps		Whole tree netting	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Siuslaw	1,135	1,553	--	--	--	--	1,725	1,183	180	200
	37%	53%	--	--	--	--	57%	40%	6%	7%
Willamette	918	378	1,000	1,500	782	1,322	--	--	116	150
	32%	11%	35%	43%	27%	38%	--	--	4%	4%
Mt Hood	438	892	--	--	--	--	--	--	--	--
	100%	100%	--	--	--	--	--	--	--	--
TOTALS	**2,491**	**2,823**	**1,000**	**1,500**	**832**	**1,472**	**1,725**	**1,183**	**296**	**350**
	39%	**39%**	**16%**	**20%**	**12%**	**18%**	**27%**	**16%**	**5%**	**5%**

Table 8A.--Acreages and percentages of seedling protection materials used in Oregon Forestry Department Districts in 1982 and 1983.

District	Rigid plastic mesh tubes		Waterproof paper bud caps		Whole tree netting		Acetate climbing barrier		milk carton		Plastic netting bud caps	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Coos Bay	1,678	792	--	--	--	--	2	8	--	--	--	--
	99.9%	99.%	--	--	--	--	0.1%	1%	--	--	--	--
Tillamook	900	500	--	--	--	--	--	--	--	--	--	--
	100%	100%	--	--	--	--	--	--	--	--	--	--
Astoria	--	25	1,620	175	1,440	150	--	--	--	--	--	--
	--	15%	55%	45%	45%	40%	--	--	--	--	--	--
Forest Grove	--	--	400	400	--	--	--	--	--	--	--	--
	--	--	100%	100%	--	--	--	--	--	--	--	--
Santiam	150	200	--	--	--	--	--	--	--	--	--	--
	100%	100%	--	--	--	--	--	--	--	--	--	--
Philomath	71	148	13	38	--	--	--	--	2	4	--	--
	83%	78%	15%	20%	--	--	--	--	2%	2%	--	--
Veneta	30	--	--	--	120	--	--	--	--	--	150	--
	10%	--	--	--	40%	--	--	--	--	--	--	--
Grants Pass	--	71	--	--	--	--	--	--	--	--	--	--
	--	100%	--	--	--	--	--	--	--	--	--	--
TOTALS	**2,829**	**1,736**	**2,148**	**733**	**1,600**	**150**	**2**	**8**	**2**	**4**	**150**	**0**
	42%	**66%**	**32%**	**28%**	**24%**	**6%**	**0.1%**	**0.3%**	**0.1%**	**0.2%**	**2%**	**--**

APPENDIX B

Regional manufacturers and suppliers of materials to protect forest seedlings from animal damage - 1983:

Company	Product
J.L. Darling Corp. 2212 Port of Tacoma Rd. Tacoma, WA 98421 (206) 385-1714	Waterproof paper bud caps
Forest Protection Products Co., Inc. 1420 North 7th St. P.O. Box 1057 Coos Bay, OR 97420 (503) 267-2622	Rigid plastic mesh tubes flexible netting, bamboo supports
International Reforestation Suppliers 2100 W. Broadway P.O. Box 5547 Eugene, OR 97405 (503) 345-0597	Waterproof paper bud caps, polyester bud caps, rigid plastic mesh tubes, flexible netting, bamboo supports, Big Game Repellent[R] Conibear 110 traps, rodent bait
Mammal Survey and Control 216 North Tillamook Portland, OR 97227 (503) 282-2656	Rodent bait
Newell Wholesale Nursery P.O. Box 372 Ethel, WA 98542 (206) 985-2460	Seeds of native forage plants preferred by wildlife
Oregon Rodent Control Outfitters P.O. Box 361 Eugene, OR 97440 (503) 345-0515	Rodent bait, rabbit bait
U.S. Fish & Wildlife Service Pocatello Supply Depot 238 E. Dillon St. Pocatello, Id 83201 (208) 236-6920 FTS: 8-554-6920	Rodent bait Macabee gopher traps (For sale only to federal agencies.)
Wilbur Ellis Company P.O. Box 8838 3145 NW Yeon St. Portland, OR 97208 (503) 227-3525	Big Game Repellent[R], Scram 42S[R] (TMTD), rodent bait.

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